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[The following are translations of selected articles in the Russian-language monthly journal AVIATSIYA I KOSMONAVTIKA published in Moscow. Refer to the table of contents for a listing of any articles not translated.]

AVIATION AND COSMONAUTICS

No 1 January 1990

Tactics as Element of Air Combat Training

90R90001A Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 1-3

[Interview with Lt Gen Avn A. Bobrovskiy, candidate of military sciences, deputy commanding officer for instructional and scientific activities, Military Air Academy imeni Yu. A. Gagarin, and Docent Col V. Shubin, candidate of military sciences, air tactics department head, by AVIATSIYA I KOSMONAVTIKA correspondent: "Tactics in Combat Training"]

[Text] *Training in tactics is the culmination phase of combat training, the stage at which all the central professional qualities of the combat pilot are formed.*

Lt Gen Avn A. Bobrovskiy, candidate of military sciences, Military Air Academy imeni Yu. A. Gagarin, deputy commanding officer for instructional and scientific activities, and Docent Col V. Shubin, candidate of military sciences, head of the department of air tactics, took part in a discussion of this important problem with a correspondent from the magazine AVIATSIYA I KOSMONAVTIKA.

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[AVIATSIYA I KOSMONAVTIKA] Comrade Lieutenant General, the Air Force has entered the new training year in a condition which is defined by a number of important elements: a reduction in strength level, a continuing process of mastering the latest aircraft, the entry into operational service of qualitatively new weapon systems, etc. What effect is this having on operational training?

[Bobrovskiy] Yes, the Air Force, as one of the basic components of the might of our Armed Forces, is undergoing substantial changes. This is a result of practical steps being taken by the USSR to reduce the level of military confrontation with the United States (the Warsaw Pact with NATO) and to implement the defensive thrust of Soviet military doctrine.

The cutbacks in the Air Force by no means signify, however, a decrease in the Air Force's combat capabilities. A high degree of operational readiness and warfighting capability on the part of Air Force units and subunits will be maintained by means of qualitative parameters.

The fact that new-generation aircraft and the latest weaponry are entering operational service is altering the character and conditions of combat employment of air forces and is imposing tougher demands on aircrew training and on the ability of commanders at all echelons quickly to perform situation estimates and predictions, to make intelligent decisions, and to implement these decisions. But the experience of local conflicts and training exercises also attests to the need to change views on air tactics.

A high degree of combat proficiency presupposes the ability to defeat a powerful, well-armed and highly-trained adversary. Today, however, the level of combat proficiency in the line units is not fully in conformity with the demands of the time. What are the reasons for this?

First of all, unnecessary simplification in the approach to training flight personnel and improving their professional skills, for it is no secret that frequently the tactical environment and various combat situations laid out on maps during preparation for tactical air exercises and field training exercises remain purely on paper. The actual sorties, however, are flown according to a long-since mastered scheme, without active opposition by the "adversary." And if there is opposition, the OPFORCE as a rule is flying the same kind of aircraft, and all actions are known in advance down to the slightest details. How can one expect genuine combat confrontation if the "adversary" is represented not even by different regiments within the division but by neighboring squadrons? Of course there cannot be any real contest. But why is it that commanders permit actions characterized as actions geared to show and pretense? The answer is quite simple: they are making it easier for themselves to get a high mark.

An inadequate level of tactical proficiency sometimes forces one to resort to oversimplification, and there is no way to hide it. Poor knowledge of the fundamentals of combined-arms combat and the capabilities of the potential adversary's aircraft and air defense assets force one to conduct combat training in a monotonous tactical environment, to fly missions along well-traveled routes, and to deliver strikes on thoroughly-familiar targets.

Secondly, the approach to matters of tactics has not undergone any appreciable changes even with entry of the latest aircraft into operational service. For various reasons, commanders deal with issues of tactics on a sporadic basis. In addition, lack of close communication with Air Force research establishments and educational institutions limits the possibilities of practical adoption into combat training of new points of tactics applying to the various air components [rod aviatsii: fighters, bombers, etc].

Thirdly, the times demand that leader and flight personnel be broad-area specialists. Practical mastery of the skills of command and control of units and combined units in a complex combined-arms battle environment is simply mandatory for the corresponding Air Force commanders. But one fails to observe adequate initiative on their part in organizing tactical air training, since there continues to occur constant, excessively-close supervision by higher echelons; the fact that people are unaccustomed to independence of action is another contributing factor.

[AVIATSIYA I KOSMONAVTIKA] You mentioned negative consequences caused by lack of close communication between line units and Air Force educational institutions. Just what are the role and tasks of science in the process of gaining combat proficiency?

[Bobrovskiy] It is a well-known fact that a high degree of combat proficiency is a result of skilled application of the points of military science, and tactics in particular, in practical training, that is in the process of combat training. Party and government documents spell out the strategic line of policy in development of science: a decisive shift toward realistic, practical tasks. What requires priority attention in this connection? In our opinion the matter of fullest utilization of the technical capabilities of aircraft systems is becoming a particularly acute issue. Air supremacy will be gained by he who more skillfully utilizes airborne and ground assets for command and control, reconnaissance, air defense penetration, for getting through to the target and for guiding weapons to the target.

Electronic warfare, as a category of combat confrontation, also requires elaboration of tactics. It is high time to view EW not as a supporting activity but as an integral element of combat operations.

Achieving the element of surprise which, as we know, constitutes the basis of success in battle, represents an important problem. Nowadays, however, with a sophisticated system of radar detection, it is impossible to achieve the element of surprise solely by means of concealment or stealthiness of actions. Therefore other methods must be sought, possibly involving special organization of employment of forces and assets (including EW), various forms of deception, etc.

Matters pertaining to coordination among the various air components require detailed examination. Study and investigation of joint operations by composite forces of fixed-wing (rotary-wing) aircraft of different types is of considerable practical value.

[AVIATSIYA I KOSMONAVTIKA] Could you tell us about the contribution made by the Military Air Academy toward resolving these problems?

[Shubin] It is playing a leading role in this area. Teaching faculty and scientific personnel are constantly working on promising solutions to problems pertaining to combat employment of air forces. In addition, they write training manuals for line units, which reflect all new developments obtained by theoretical investigation and revealed in the course of studying the experience of local conflicts and various training exercises. Our officers take active part in these exercises. This is beneficial to both parties. Commanders and flight personnel learn first-hand about research results obtained in the area of tactics, while the academy people learn about practical needs.

Tactical training is becoming an increasingly more costly business. Using training simulators and simulation systems is one way to reduce costs. Therefore various models are developed at the academy: of combat operations, combat flying, air-to-air combat, strike delivery, air defense penetration, etc. Some of these models are already being used in line units. We consider this trend to be one of the most promising in the interaction between science and practical activities.

[AVIATSIYA I KOSMONAVTIKA] Of course the link between science and practical activities is not limited to interaction between the academy and line units. How can this problem be resolved within the system of Air Force cadre training?

[Bobrovskiy] The main component in any system of education is the teacher (flight school instructors, squadron and regimental commanders, academy teaching faculty). His professionalism, methods skill and corresponding personal qualities are essential conditions for success. Of course in addition to this there should be an efficient structure of instruction, optimal schedules and programs, modern training facilities, and effective methods.

A rational structure of training and instruction envisages designation of specific stages or phases in tactical training, such as the sequence school - line unit - academy - line unit. This is a base variation. Others are also possible. But no matter what structure is taken as a basis, it is essential correctly to determine the content of training at each stage and to ensure consistency, succession, and depth of study of Air Force tactics. Fullest realization of this principle is possible with a uniform integrated program.

A great deal of work experience in line units as well as research activity convince me that at each stage study of theory should end with practical testing and verification of that theory. The pilot cadet, the journeyman pilot, and the regimental commander must experience in the air all the advantages and drawbacks of what for them are new tactical moves, modes of operations, formations, etc. I view this as one of the directions to take in restructuring the system of training Air Force command cadres.

[AVIATSIYA I KOSMONAVTIKA] Perestroyka of military education apparently postulates not only a deepening of the interaction between science and practical applications, although this can be designated as a main problem. What other issues must be resolved in order to improve the quality of combat training?

[Shubin] I would specify three principal aspects: improvement in screening and selection of candidates for command assignments, purposeful training of instructor cadres, and improvement in organization and execution of the instructional process.

In my opinion the presently-existing system of screening and selection of candidates for command assignments is not focused on searching for and advancing capable

officers, and as a consequence of this it shows a low degree of efficiency. A fairly high percentage of commanders being relieved of their positions serves as confirmation of this. It seems to me that the following scheme makes greater sense. In the units there is in progress a constant study of the abilities, personal qualities, and proclivities of all flight personnel. Candidates for academy enrollment are selected from the results of this work. They take entrance examinations on a competitive basis and return to their combined units upon completion of study. Subsequently those officers who stand out are sent to take special courses of training, where they receive thorough preparation for performing job duties in the next-higher billet. With such a stage-by-stage approach one can considerably lessen the probability of possible mistakes and avoid overexpenditure of funds on training highly-skilled commanders.

The teaching faculty situation is similar. Incoming instructor personnel at Air Force schools and at the academy are for the most part officers who for various reasons are no longer flying. That is, this does not constitute a purposeful search for and selection of individuals with a proclivity and abilities for research and teaching activities. Difficulties with establishing independent schools of talented teaching faculty are an inevitable consequence.

And one last point. A certain reserve of applied knowledge helps an academy graduate quickly adapt to his new duty assignment. Further growth, however, as well as the ability independently to maintain his operational-tactical thinking at a level corresponding to changing demands, are possible only with adequate fundamental preparation of the future Air Force commander.

Specialization ensures readiness to perform the missions characteristic of each air component or branch of military aviation. But one can skillfully organize coordination among units and combined units of the different air components and branches of service only with appropriate universality or generalization of military education. For this reason one of the most important tasks of restructuring of the training process is to achieve an optimal ratio of the above-named types of training.

[AVIATSIYA I KOSMONAVTIKA] Upgrading and improvement of hardware is perhaps taking place more rapidly in the Air Force than in any of the other services. This directly affects Air Force tactics. Which points of tactics in your opinion today require greater attention in the course of organization and conduct of combat training?

[Bobrovskiy] Several stages are noted in the evolution of Air Force tactics. The Great Patriotic War was the most significant of these stages. Fundamental points of tactics of combat and strike delivery with visual acquisition of information on the target of attack formed in the course of this war.

Postwar improvement of aircraft and aircraft armament engendered long-range air-to-air combat, all-aspect weapons delivery, dispersed formations, changing of the role of the wingman in the two-ship element, air-to-ground strike standoff weapons delivery without coming into range of hostile air defense assets, etc.

Development of correct concepts of modern tactics should be grounded on an objective analysis of all factors which determine its development, for tactics is not only the most dynamic but also the most extensive area of military knowledge. Each replacement of one generation of weapon by another affects tactics first and foremost, invariably producing new modes of operations and tactical moves, filling already-known forms with new content.

Air Force tactics is presently at a point beyond which lie new concepts, patterns, mechanisms, and principles. These still remain to be perceived. I shall state a number of preconditions present for the further evolution of tactics. These include primarily nonvisual or instrumental target detection, multichannel weapons delivery systems, which provide capability to hit several targets simultaneously, automation of operations involved in readying weapons for delivery, as well as future automation of the process of in-air decision-making for a number of standard situations, and reduction to a minimum of the time interval between target detection and effective engagement.

I would therefore consider the following as new points requiring greater attention in the course of combat training: development of tactics of combat and strike delivery with simultaneous engagement of several targets; organization of joint actions by forces and assets with differing combat performance characteristics; tactical command and control in conditions of real-time acquisition and processing of information on the adversary; conduct of autonomous operations in conditions of a complex electronic environment.

[AVIATSIYA I KOSMONAVTIKA] Up to this point our discussion has dealt with objective factors which define the role and place of tactics in combat training, its content and preconditions for successful practical adoption. What can you tell us about the subjective element in this problem?

[Shubin] The activities of Air Force commanders are akin to the work of scientific researchers. Analysis of environment and situation conditions, combat capabilities and reasonable action variations, and determining matters pertaining to comprehensive support essentially constitutes combined or integrated research. Proceeding from this, implementation of new points of Air Force tactics and consideration of development trends in Air Force tactics in combat training is also a complex process and is naturally subject to the influence of the subjective factor.

Commander subjectivism affects the condition and directional thrust of training, and consequently affects the operational readiness of air subunits, units, and

combined units. One can single out two aspects of its manifestation: a psychological aspect and a pedagogic aspect.

The former consists in the fact that military aviators put up certain resistance to new tactical ideas at the learning and assimilation phase. This is entirely logical and explainable, for as a rule one approaches new convictions through one's mistakes and experience. And even when activities are connected with defending the interests of the state, certain efforts are required in order to diminish the influence of the psychological aspect.

The second aspect is manifested in the fact that combat training is directed toward the development of required qualities on the part of the pilot and the commander. Of course it is important to learn fully to utilize the capabilities of one's combat equipment. It is no less and perhaps even more important, however, to develop excellent moral and fighting qualities. It is precisely for this reason that they are a component of tactical training, which is defined as the art or skill of the commander.

In order for the state and condition of Air Force combat training to meet today's requirements, it is essential constantly and purposefully to work to ensure that flight personnel gain a precise understanding and comprehension of modern views on the employment of air forces. And this task is accomplished by practical implementation of the principle "teach the troops that which is necessary in war."

New Approach to Defining Frontal Aviation Missions

90R90001B Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 4-5

[Article, published under the heading "Combat Training: Debates, Suggestions," by Military Pilot 1st Class Col V. Tkachev, docent, candidate of military sciences: "A New Approach Is Needed"]

[Text] Combat missions are determined in conformity with the function of a specific air component [rod aviatsii: bombers, fighters, etc] and proceeding from objective necessity. This circumstance presupposes a common understanding of missions by all persons taking part in military operations. For this purpose the combat missions of units and combined units of the different air components should be classified according to a common attribute (or set of attributes) and formulated in a uniform manner. In the ideal situation attributes should be uniform for all branches of service.

This situation does not prevail at the present time. This is particularly noticeable when comparing formulations of the missions of combined units and units of different air components, although there is a certain similarity at first glance. With coinciding areas of combat employment, similar targets and modes of operations, frontal-aviation [tactical] bombers, fighter-bombers and ground-attack aircraft are called upon to perform missions which differ in formulation and quantity. This disparity gives rise to a paradox: while delivering strikes on the same targets, combined units and units will perform different missions, that is, a combat mission is not objective but depends only on what air component has been assigned a given target.

In order to do away with multiple variation and ambiguity of interpretation of missions by combined-arms and air command authorities when planning combat operations, a new classification is needed. Also speaking in favor of this is the incomplete encompassment in existing formulations of the entire aggregate of targets and nature of actions by combined units and units in specified areas of combat employment or weapons delivery. For example, execution of diversionary or decoy actions, destruction of stretches of road and road-associated structures in defiles and at chokepoints, creation of roadblocks consisting of rock debris, structural and demolition rubble, creation of fires, and creation of smoke screens are not reflected in combat missions, and yet such actions may be performed fairly frequently in an actual combat situation.

Obviously the list of combat missions for each air component should encompass the entire diversity of targets, and should also reflect the nature of actions by subunits and individual aircrews during a mission. Otherwise the assignment of missions not indicated in regulations will lack legal foundation.

At the present time combat missions are formulated in such a manner that they are grouping into primary and secondary. This situation evokes some question, since a specifically assigned mission is always primary for a combined unit or unit. But if we proceed from the existing provision, such as engagement of amphibious landing force targets, indicated in the list of primary missions, this will not be a primary mission for those combined units or units based at a considerable distance from maritime theaters.

Adoption of precision weapons into operational service is increasing the effectiveness of air actions, as a result of which units and combined units can be assigned the mission of destroying a large number of targets which differ in makeup or composition, affiliation, and function. The objective principle of determining missions is unacceptable in this case, for the following situation is possible: the number of missions will be equal to the number of targets specified. Therefore this principle should be retained only for individual aircrews and subunits (elements), while for units and combined units it makes sense to consolidate missions according to an attribute which is common to all air components. This will make it possible to classify combat missions and to achieve identical missions treatment and interpretation.

The proposed approach is grounded on the existence of a number of missions which are common to several combat arms or components, without accomplishment of which attainment of success in the combat engagement and operation becomes difficult or impossible. Each of these can be divided into particular missions in conformity with the tasking function and area of operations of the different air components. The results planned for all forces taking part in combat operations, however, should as an aggregate ensure attaining the main objective. Particular missions are in turn made specific in relation to the type and conditions of combat operations, employed weapon assets, combat readiness, combat effectiveness, and combat capabilities of the combined units and units. With this approach, going against the same target, they will perform identical missions, regardless of their affiliation (see diagram following this article).

No	Missions	Methods of Accomplishment	Targets
1	2	3	4
1.	Close support of ground troops. Objective: to create favorable conditions for operations of first-echelon combined units and airborne/air assault forces.	1. Destroying personnel and combat equipment.2. Laying blinding smokes and masking smoke screens. 3. Restricting maneuver of men and equipment by mining objectives and areas of terrain. 4. Illuminating targets with parachute flares. 5. Explosive minefield clearance (clearing lanes).	Company and platoon strongpoints [defensive positions], field artillery batteries and battalions, multiple rocket launcher systems, first-echelon tank and motorized infantry subunits, sections of terrain, minefields.
2.	Preventing reserves from moving up and deploying. Objective: to maintain (create) a favorable force ratio for friendly ground troops in selected sectors, in a zone or area during a specified (requisite) period of time.	1. Destruction of personnel and combat equipment in assembly or concentration areas, on the march, and at lines of deployment or release points. 2. Destruction of crossing sites, bridges, and other manmade structures on routes of movement of advancing reserves. 3. Creation of obstructions and obstacles on routes of movement of advancing reserves (flooded areas, obstructions consisting of structural and demolition rubble, rockslides, fires). 4. Laying mines in enemy unit position areas, areas of terrain, stretches of road.	Artillery, tank and motorized infantry subunits on the march and in assembly and concentration areas, dams, bridges, crossing sites, areas of terrain, tracts of forest, rockfall-hazard slopes above roads.
3.	Disruption of command and control system activities at tactical depth. Objective: to diminish capabilities to bring to bear the combat power (combat potential) of combined units, units, and subunits, as well as the firepower of specific weapons.	1. Effective engagement of command and control facilities, communications facilities, and radar facilities, including preventing restoration to service (by laying mines, starting fires, etc). 2. Decoy (diversionary) actions by individual aircraft and groups of aircraft. 3. Disruption of the operations of command and control system facilities by creating adverse conditions (fires and flooded areas, obscuring smokes, decoy targets). 4. Scattering disposable jamming transmitters in radar and command and control facility communications facilities disposition areas.	Command posts of army corps, brigades, divisions, air defense control and warning centers and control and warning posts, tactical air control centers, close air support control facilities, command and control facility antenna arrays, radar sites, integrated reconnaissance and strike system beacons, etc.
4.	Engagement of army-aviation aircraft, ground-attack aircraft, and unmanned aerial vehicles. Objective: to diminish intensity or prevent reconnaissance and strikes on ground-troops targets and installations by helicopters, ground-attack aircraft, and UAVs.	1. Destruction of fixed-wing and rotary-wing aircraft and UAVs at airfields and landing sites. 2. Destruction of fixed-wing and rotary-wing aircraft and UAVs in the air. 3. Disruption of operations of army aviation, ground-attack aviation, and UAV subunits by mining runways and flightline-ramp areas (aircraft dispersed parking/flightline deployment areas).	Ground-attack aviation and army aviation landing sites and airfields, UAV launch locations and rear area control facilities, runways, aircraft dispersed deployment areas, fixed-wing and rotary-wing aircraft on the ground and in the air.

5.	Engagement of airborne/air assault forces. Objective: to prevent the establishment, to accomplish localization or elimination of areas of combat engagement with hostile forces behind friendly lines.	1. Destruction of assault force personnel and equipment in assembly areas and troop pickup zones. 2. Destruction of fixed-wing and rotary-wing aircraft carrying the assault force en route and in the landing zones. 3. Destruction of assault force personnel and equipment in the landing zones. 4. Isolation of assault forces in the landing zones by emplacing minefields around the perimeter of their location and on routes of advance.	Airmobile and motorized infantry subunits, fixed-wing and rotary-wing aircraft at airfields, troop pickup sites, in the air and in the landing areas, areas of terrain.
6.	Engagement of air defense assets. Objective: to eliminate or reduce losses of friendly aircraft during performance of combat missions.	1. Effective engagement of SAM and AAA subunits, detection and guidance facilities. 2. Decoy and diversionary actions by individual aircraft and groups of aircraft. 3. Laying down protective screens of heat flares and smoke screens. 4. Placement of expendable jamming transmitters. 5. Employment of discrete passive decoys and interference. Starting fires and causing flooding in air defense assets disposition areas.	Long-range, medium-range, and short-range SAM systems, control and warning centers and posts, radar sites, AAA subunits on the march and in firing positions, areas of terrain, tracts of forest, dams.
7.	Disruption of first-echelon combined unit rear services activities. Objective: to impede efforts to achieve the combat potential of weapons subunits, units, and combined units.	1. Destruction of supplies and munitions at supply depots and other storage locations. 2. Destruction of facilities and equipment involved in transporting materiel and munitions. 3. Prevention (delay) of transport of materiel by mining areas of terrain and rear services facilities. 4. Creation of obstacles and obstructions on supply routes. 5. Destruction of fixed-wing and rotary-wing transport aircraft on the ground and in the air.	Ammunition, POL, and combat equipment storage depots and other storage sites, rail consists, truck convoys, railyards, manmade structures along rail lines and highways, fixed-wing and rotary-wing aircraft in the air and on the ground, areas of terrain, rockfall-hazard slopes above roads.
8.	Air reconnaissance. Objective: acquisition of requisite situation intelligence, intelligence on the enemy's intentions and actions, and strike results.	1. Follow-up reconnaissance for strike elements. 2. Reconnaissance incidental to the performance of other missions. 3. Mission-specific reconnaissance for the benefit of ground forces. 4. Decoy or diversionary actions.	All targets, sites and installations located within the area of employment of the specific air component.

Implementation of this proposal requires the adoption of a new term—"mode or method of accomplishing a combat mission," which is defined as the nature or character of action taken against the enemy which leads to achievement of the stated goal or objective. Together with the existing term "mode of combat operations," which determines the manner and procedure of employment of men and equipment, it can comprise a "mode of performance of the combat mission."

Each mission is of course accomplished not by one mode or method, and therefore the mode or method should either be indicated in the course of mission briefing or should be selected independently by the executing individual according to the situation, weapons availability, and other factors. In the latter case the combat mission is assigned with mandatory specification of the result which is to be achieved. For example, to delay for two or three hours the advance of a tank (motorized infantry) battalion to be committed to battle, to prevent the operation of a facility or repair activities on the facility for a specified period of time, etc.

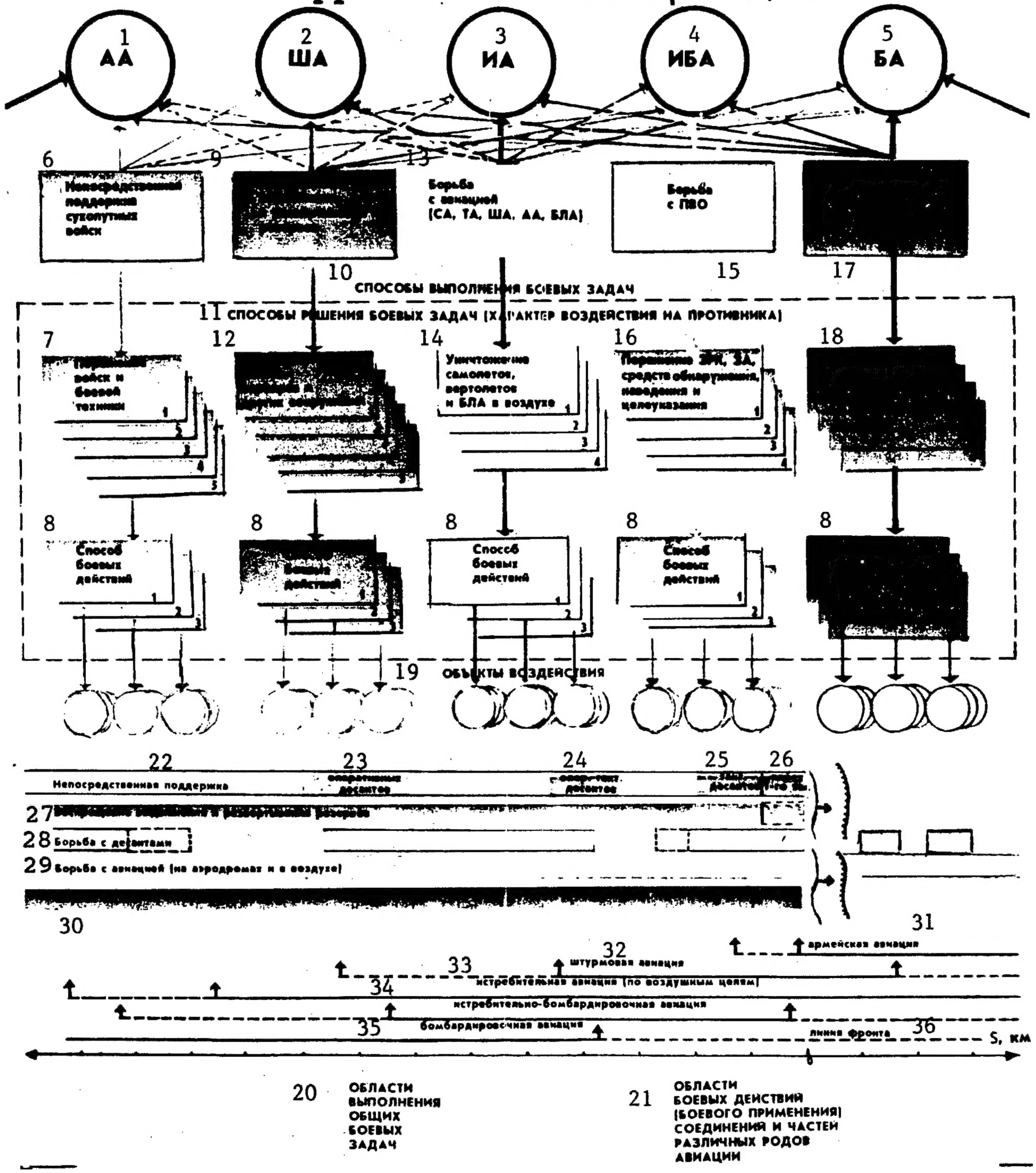
As an illustration, the table contains a listing of missions, modes or methods of their accomplishment, and corresponding targets for one of the frontal aviation components (variation). As a supplement to the above, missions and modes of accomplishment can be determined which are characteristic only of the other frontal aviation components, missions and modes which are not in conflict with the general approach.

Classification of Tactical Air Missions

90R90001C Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 24-25

[Annotated diagram: "Classification of Combat Missions of Frontal Aviation (a variation)"]

Систематизация боевых задач фронтовой авиации (вариант)



[Text]
Key:
1. Army Aviation
2. Ground-attack aircraft
3. Fighters
4. Fighter-bombers
5. Bombers
6. Close support of ground troops
7. Destruction of troops and combat equipment
8. Mode of combat operations
9. Interdiction of advance and deployment of reserves
10. Mode/methods of accomplishing combat missions
11. Mode/methods of executing missions (nature of engagement)
12. Destruction of bridges, crossings sites, and other structures
13. Engagement of aircraft (strategic bombers, tactical aircraft, ground-attack aircraft, army aviation, unmanned aerial vehicles)
14. Destruction of fixed-wing and rotary-wing aircraft and UAVs in the air
15. Engagement of air defense assets
16. Destruction of SAM missile systems, AAA, means of detection, guidance, and target designation
17. Engagement of airborne/air assault forces
18. Destruction of assault troop-carrying fixed-wing and rotary-wing aircraft in the air
19. Targets
20. Areas of accomplishment of overall combat missions
21. Areas of combat operations (combat employment) of combined units and units of the various air components
22. Close support of
23. Operational-level airborne/air assault forces
24. Operational-tactical assault forces
25. Tactical assault forces
26. First-echelon forces
27. Interdiction of advance and deployment of reserves
28. Engagement of airborne/air assault forces
29 Engagement of aircraft (on the ground and in the air)
30. Engagement of air defense assets
31. Army aviation
32. Ground-attack aircraft
33. Fighters (against air targets)
34. Fighter-bombers
35. Bombers
36. FLOT

Blinder Bomber Regiment Strives to Improve Operational Readiness

90R90001D Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 6-7

[Article, published under the heading "Anticipating the 28th CPSU Congress," by Lt Col N. Antonov: "Difficult Steps of Renewal"]

[Text] The airmen of the long-range bomber regiment were engaged in carrying out a critical, difficult mission at a tactical air exercise. They were to redeploy to a different base and to fly a strike on "enemy" targets. They were given a complex tactical environment: they could expect heavy air defense opposition en route and when approaching the target, and limited visibility was making the bomber redeployment difficult. In addition, the mission had to be completed within a limited time frame.

The men performed aggressively from the very commencement of the tactical air exercise. Many demonstrated a high degree of skill. These included the aircrew of party member Gds Capt P. Malafeyev. This aircraft commander, a military pilot 1st class, has logged more than 1,480 hours in the air. Navigator Gds Sr Lt V. Bayerbakh, the aircrew's party group organizer, is as proficient as the aircraft commander. Weapons officer Gds Sr Lt V. Kolesnikov is also an expert at his job.

As we see, party activists and Communists stood in the front ranks of those who distinguished themselves. This attests to the militance of the party organization, of the unit as a whole, to the men's dedication to fighting traditions, and to their endeavor in the year of the 28th CPSU Congress to achieve specific qualitative improvements in their job performance. And in some areas to regain previously lost ground. To fill out the picture, we shall take a brief excursion back into the past.

The regiment was formed in 1941. It was equipped with TB-7 (Pe-8) bombers, which were excellent aircraft for that time. Pilots and navigators from combat bomber units, civil aviation, and Arctic aviation formed the nucleus of the regiment. Most had experience in flying in instrument weather both day and night. Personnel were multiethnic in composition from the very beginning. Georgian D. Chkhikvishvili, Ukrainian A. Shtepenko, Estonian E. Pusep, and Russian P. Mosolov blended into an integral fighting family. The regiment's first open party meeting was held in August 1941. They discussed a single agenda item: how best to smash the enemy. Soon the regiment received orders to fly a raid on Berlin, the capital of Fascist Germany. On 10 August Hero of the Soviet Union Brigade Commander M. Vodopyanov led a force out on this mission. They released their bombs precisely onto the target. This event was not only of military but also of great political significance.

Subsequently the regiment's aviators flew successful raids on enemy military-industrial targets in Danzig, Koenigsberg, Bucharest, Budapest, Stettin, and other cities.

The men also flew important special missions for the government. In the spring of 1942, for example, Maj S. Asyamov and his crew flew a Soviet military-diplomatic mission from Moscow to London. Maj E. Pusep's crew brilliantly accomplished a flight from Moscow to the United States and also transported a Soviet Government delegation to Moscow.

During the war this regiment took part in all major Soviet operations. It was designated a guards regiment in 1943, and

subsequently was awarded an honorary name designation. Eleven Heroes of the Soviet Union served with this regiment.

In the postwar years as well the men of this regiment marched as right-flankers among long-range bomber units. They were among the first to master the new Tu-4 bomber, and subsequently the Tu-16. These were subsequently superseded by supersonic missile-armed aircraft.

But there were also less brilliant pages in the history of these guardsmen. There were years when it seemed that the commanders were doing their job, as were the political officers, and it seemed that the subunit party organizations were making the right decisions, but the men were backsliding in their training performance. There occurred air mishaps and near-mishaps through the fault of personnel, as well as disciplinary infractions.

In the higher-level political agency they noted with concern a decline in the vanguard role of party members within the unit. There were many reasons for this. One reason was the fact that some leader-Communists had lost their enthusiasm for military service and had become morally degraded. What kind of personal example or moral right to teach and indoctrinate subordinates can there be if, for example, several regimental-echelon political workers were discharged into the reserves just ahead of formal charges being brought against them.

Unquestionably incompetence, dissoluteness, and hypocrisy by the "brass" engendered apathy and distrust of others in the men. The situation which developed was quite typical for the period of stagnation.

It is understandable that something which flourished over a period of many years cannot be corrected in one instant, particularly if one is dealing with the human factor. Nevertheless changes came. In many respects they began with the party committee and with refurbishing of party work. Party committee secretary elections were conducted in a totally new manner. Party members declared that they no longer wanted to elect persons recommended "from above," persons who were sometimes incompetent. Each candidate recommended to the party committee would be discussed thoroughly.

Take just the following fact, for example: at that time far from the overwhelming majority of CPSU members voted for the present secretary. Some were unhappy about the fact that he too had come from another regiment. But he was a military navigator 1st class, with party work experience at the detachment and squadron level, and a squadron deputy commander for political affairs. Many knew him because they had served with him. Their opinion proved determining.

Thus Gds Lt Col V. Shestakov became party committee secretary. A year has passed since his election. What new things has he brought to the party organization and to all regimental personnel?

"I cannot give a simple answer to this question," says Vladimir Iosifovich. "Restructuring of party work is proceeding with difficulty, at times with conflict and contradiction. On the one hand we have not yet freed ourselves of the old work forms and methods. On the other hand, the on the whole justified endeavor to achieve radical changes as quickly as possible sometimes fails to produce benefit. One thing is clear: results in training, in improving flight safety and in strengthening military discipline depend first and foremost on how well we succeed in overcoming the alienation on the part of some party members from the activities and concerns of the collective, bringing back the vanguard role or party members in place of apathy and passivity."

The secretary is right. Performance is judged on the basis of end results. But results cannot be achieved by scattering one's efforts, in the attempt to encompass everything at once. For this reason last year the party committee concentrated its attention on the main thing that determines unit operational readiness—the quality and effectiveness of performance of the regiment's missions. In addition to narrowly specialized matters, however, they also worked on other matters, directly linked with the overall problem, pertaining to forming and renewing socialist consciousness in people and their ethics, ensuring a vanguard role by each and every party organization and every party member in perestroyka, manner of dealing with the men's needs and moods, plus other items.

They began with the simple—carrying out their own decisions. Not decisions consisting of dozens of points, with abstruse formulations, but clearly-stated, thoroughly thought-out and essential decisions, such as those which were adopted back in 1941 at a party meeting with the agenda "How best to smash the enemy." From this position it became clear that it was essential to have a specific talk with leader-Communists on increasing their responsibility for ensuring the subunits' combat readiness and improving the level of professional skill on the part of pilots, navigators, engineers and technicians; what is needed is an exchange of know-how and experience among specialist personnel and organization of additional training classes, consultation sessions, and training drills. For example, the command authorities noted improvement in the performance of the aircrews of the squadron commanded by Military Pilot 1st Class Gds Maj A. Korolev. The squadron's crews had performed tactical launches with greater success. The squadron also is recording fewer air mishaps and near-mishap situations through the fault of personnel. In short, one could learn useful things from this squadron. And, following the recommendation of the party committee, many party members, such as N. Borodinov, Zh. Valeyev, and others, shared their experience and know-how with their comrades and kept a particularly close eye on those experiencing mistakes and various problems with performance. This has produced good results.

Such a work form as receiving accountability reports by party members also continues to be utilized with benefit.

At report sessions, however, the party committee endeavors to clarify not purely specialized matters but rather those involving the human factor, affecting people's job-related training and mood. At one meeting, for example, leader-Communists N. Novoseltsev and A. Yerusenko related how they get to know the needs and concerns of their men, how they study their moods and attitudes and influence the forming of these attitudes. The discussion proved beneficial, because it revealed the psychological linkage between so-to-speak everyday problems pertaining to the men's daily lives and matters pertaining to combat readiness.

The party committee enlists as many Communists as possible in this work. Toward this end, working groups were formed for all areas of activity, with several persons from different subunits in each group. And if, let us say, preparations are being made for a party committee meeting dealing with problems of flight safety, not a limited number of chosen activists takes part in this, but rather a group of competent specialists. For example, examining this problem in the squadron under the command of Gds Lt Col V. Repin, comrades V. Kabanov, A. Seleznev, and S. Senyakin provided considerable help to party committee members officers N. Kutsakov and A. Burt. In particular, they arranged for the requisite work to be done with aircraft commanders and party group organizers. On the whole such a work form has caught on and is proving effective.

We must also note a unity of agreement between the command element and party committee on the importance of glasnost and democratization of the affairs of the party organization and the entire collective. At the initiative of Gds Lt Col V. Kashirin, for example, an aircraft commanders council has begun functioning within the regiment. It is planned to invest it with considerable authority and to discuss the most varied, vitally-important issues.

They have followed the same direction in determining matters of personnel moves. The proceedings of the certification board are now a matter of public record. Officers V. Khrapkov and A. Burt were nominated for the position of detachment commander and deputy squadron navigation officer by means of a poll.

In short, democratization, glasnost, working closer with people, and openness in discussing vital problems pertaining to combat readiness and strengthening discipline create a healthy atmosphere and put people in a mood to perform. Party members themselves mentioned this fact at a recent party report meeting.

Nevertheless the processes taking place within the collective are complex and diversified. Perestroyka is not proceeding without problems. There are many inhibiting elements. One of them is the fact that for many years unit personnel have been more or less stable, and there are not many young people. Perhaps it is in part for this reason that there has appeared an entire category of individuals who are not serving but are rather serving out their time. They have developed selfish interests, indifference, and inactivity. Some do not even hide this fact, while others attempt to conceal it in some manner.

And the impression is created that the party bureau and party committee arrange work with them in relation to their position: the higher it is, the less firm their approach to a given party member. For example, considerable adverse criticism was leveled at party member V. Repin for slipshodness on the job and for a diminished sense of responsibility for the state of affairs in the subunit, where there are problems with military discipline and flight safety. But for some reason the party bureau and party committee took a passive position.

Incidentally, a waiting attitude and a certain being on one's guard are typical of a certain number of party members. It is as if they are weighing the question: who is going to win out? Will perestroyka truly lead to a renewal and normalization, or will it peter out and end up in the customary administrative, lip-service channel? For this reason each step toward reforms comes hard, with the inertia of stagnation in contest with the energy of action.

The unit command element, which has recently taken on new blood, and the party committee are aware of this and are taking an aggressive position. As is attested by the overall party experience with perestroyka, however, one must constantly move forward in order to maintain the momentum. For this collective it consists in solving urgent problems as they come up, problems about which in the past people did not even dare to speak. And these problems include not only housing and kindergarten enrollment availability, although there are problems with these things: more than 140 families are waiting for an apartment, and approximately 40 children are on the waiting list for kindergarten.

But today people are not talking about this, aware that no immediate solution is suddenly going to materialize. They are concerned not only by these issues but also by everything directly related to the regiment's operational readiness, improving flight safety, strengthening military discipline, and activation of the human factor. On the eve of the tactical flight exercise, for example, the regiment was not conducting flight operations, because an air mishap had occurred somewhere and orders had been received instructing them to carry out a number of measures in connection with this. Most pilots cannot understand such prohibitions, for they see no sense in them. An air mishap may occur with fighters, and yet strategic bomber crews are grounded. Is this the right way to do it?

The stream of "guideline" documents has not diminished at all, but the status of the aircraft commander has not been revised in a single one. And yet the people in the regiment insist that there is a need for this.

In the past as well there were barely enough aircraft servicing and maintenance personnel. But now new instructions have come down, calling for reducing the number of Aviation Engineering Service maintenance personnel. As a result the present number of aircraft

maintenance technicians and mechanics is hardly sufficient to meet actual needs. People with real concern for the cause to succeed ask: in this situation will it not happen that quantity will become quality with a minus sign?

Here is another issue requiring resolution. While a certain aircraft [Blinder bomber appears in photo accompanying article] was just entering operational service, the problem of spare parts was rather acute. The situation was explained as follows: as soon as we are in full production, there will be full availability.... Today the aircraft is far from being considered new, and this serves as the current justification for lack of spare parts. How many other aircraft will be brought into operational service "at any cost," including the cost of violation of guideline documents?

There are many persons in the regiment whose labor merits commendation. The regimental command element, endorsing the performance of the majority of personnel, nominated the top performers for government decorations. None were approved, however. If the people at higher headquarters, contrary to the opinion of the unit command element, feel that there are no grounds for commending a given serviceman, then why not announce such a decision publicly? At present everybody is in the dark on this.

The reliability of the crew-alerting system has been repeatedly discussed at party meetings, as well as the fact that electric and telephone cables have not been replaced for a great many years. But there have not yet been any changes whatsoever.

These are problems about which people are thinking, talking, and debating. They occupy the focus of people's attention and of course should fall within the domain of activities of leader-Communists and the party committee; they must be responded to. This is without question a serious matter, perhaps going beyond the framework of run-of-the-mill appraisals and actions, requiring a new approach in decision-making. But the 19th All-Union Party Conference and the Congress of USSR People's Deputies direct attention precisely to this, clearly stating the point that perestroyka is not a cosmetic means of smoothing down flaws in many areas of our daily lives but rather a radical treatment and correction of these flaws. We have confidence that the unit party committee and party organization have made a choice in favor of the latter.

Benefit of Regimental-Level Flight Safety Service Considered

90R90001E Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 8-9

[Article, published under the heading "Polemical Notes," by Lt Gen Avn Ye. Rusanov, deputy commander in chief of the Air Force, chief, Flight Safety Service: "Priorities of Flight Safety"]

[Text] **Economizing Intelligently**

It is perhaps unnecessary to argue the point that improving flight safety is a demand of the times. An end to the annual decline in the accident rate which has been occurring in the recent past (first half of the 1980s) and its stabilization during the course of the last several years at an excessively high level persuasively attest to the fact that the aggregate of traditional measures, in use for decades, aimed at reducing the number of fatal accidents and other mishaps, have practically exhausted their potential. This applies first of all, as was indicated in a recently-drafted Air Force plan for preventing air accidents, to standards-prescribing and directive measures, to oversimplified conclusions and to toughening demands in each new order issued following an air mishap (fatal accident).

A combined approach to preventing air mishaps, the majority of which occur due to a concurrence of several factors applying to the authority of various services, is resulting in a considerable diversity of preventive measures which are presently being proposed. They address organization of combat training, reliability of aircraft, professionalism of personnel, as well as medical-psychological issues. They are proposed by specialists from the central directorates, scientific research establishments, veteran commanders, and novice pilots. In general this is logical and expected, for each aviator not only sees the problem from the standpoint of his own position but also expects solution at the points of juncture with other areas of specialization, and also frequently looks for the solution beyond the boundaries of his personal experience and professional knowledge.

Unfortunately the overwhelming majority of suggestions and proposals for ensuring flight safety presented in research papers, at professional conferences and meetings, as well as individually, have a clearly-marked long-term, future-focused character and require additional funds and sometimes increased staffing as well for implementation, which is doubtful. And how are things with us? Since force reduction is taking place, do not even give a hint of a suggestion that additional personnel be acquired, even if this would help solve the problem.

In the meantime, in spite of the reduction of forces, it is my profound conviction that the most crucial of these problems should be stated, calculated, and decided. Incidentally, this is also the correct thing to do from an economic standpoint. Many people are unaware that losses from air mishaps during the training year greatly exceed combat losses sustained in Afghanistan over the same period of time. Serious thought should be given to this fact.

Why the "Filter" Did Not Work

It is obvious that basic, long-term measures to reduce the accident rate should definitely be combined and on a daily basis, with current efforts in the line units to ensure flight safety. As they say, each one should do his own job. The line-unit pilot should not stand by idly waiting for all-powerful airborne active means of ensuring flight

safety or expect ergonomic improvement in the cockpits of new generations of aircraft, and his commanding officer should not stand by waiting for a substantial improvement in the screening, selection and training of flight personnel nor for an increase in the capabilities of flight simulator systems and other such highly desirable but presently unrealistic factors. In addition, the cost of an air accident and responsibility for a mishap for these two categories—pilots and their immediate superiors—are incommensurable in comparison with any other aviation officials.

This once again emphasizes the urgent need for a reasonable combination of practical and theoretical tasks within the overall system for ensuring flight safety. For the personnel of air and supporting units, in the practical business of daily flight operations, this means not allowing air mishaps to occur through their own fault or culpability, and not allowing the occurrence of fatal accidents for all reasons (equipment design and manufacturing defects, unforeseen complications during flight, bird strikes, etc).

Unfortunately reality is far from this at present. Last year overall almost two thirds of air mishaps occurred directly due to oversights and errors of omission, mistakes and outright violations of flight regulations by personnel at the "pilot-regimental commander" level (and corresponding flight operations support and air traffic control specialist personnel). In the majority of all other cases, when mishap-threatening situations arose not through the fault of personnel, prompt and correct actions by that same category of Air Force personnel could have localized the development of these incidents. But... they also ended adversely.

Here is an example. The crew of a Military Transport Aviation heavy aircraft was on a training flight as part of an assault troop-lift element. By the second departure there was heavy cumulonimbus buildup throughout the entire area of flight operations. The aircraft was struck by lightning as it was flying around the buildup. This caused the pilot to lose his spatial orientation and knocked out the autopilot.

This situation could have been prevented or at least localized to a near-mishap or mishap-possible situation by a multilayer "filter" of personnel of various services—weather specialists, the pilot who flew final premission weather reconnaissance, the formation lead aircraft and the two-ship element leader, as well as the air traffic control team. The aircrew also would have performed with much greater confidence if it had been flight-scheduled as a regular crew which had flown together to the point of smooth crew coordination. The aircraft commander, the copilot and the flight technician [crew chief] had logged little unsupervised flying time. And, what is particularly shocking, almost all these departures from regulations and violations had previously occurred in the current training year and had resulted in very similar air mishaps, and had also been encountered during flight operations in that very same military air transport regiment. Unfortunately these incidents did not result in any preventive response, ultimately leading to tragedy. It is indeed true that nobody pays heed until the thunderclap...

Bitter Fruits of Lip Service

Why is it that adherence to flight regulations and prevention of air accidents—these two major components of flight safety—so frequently fail precisely where their quality should be the most assured—in the air and supporting units, directly in the organization and control of flight operations? We shall endeavor to analyze this question. Who in the regiment deals with matters of flight safety, and how?

The most common reply is the following: everybody deals with flight safety, from the regimental commander to the lowliest mechanic. Unfortunately, however, this is nothing but an empty declaration. In actual fact things work out as follows. Everybody indeed deals with flight safety in an indirect way, but together with other numerous job duties. For this reason flight safety is frequently given attention according to the residual principle, and problems are resolved in an unorganized and lip-service manner. This primitive but universal practice is inevitably revealed during any sufficiently thorough investigation of an air accident when, in spite of the many "completed" entries in the lists of planned measures to improve flight safety, it turns out that many crews are simply poorly aware of procedures in response to in-flight emergencies. Practice drills are not conducted, especially for leader personnel, but are merely marked off as completed, and runway arresting gear goes for long periods of time without being in proper working order. And aircraft proceed from practice areas and airways to the airfield in violation of routings and procedures prescribed by the Manual of Flight Operations, as the pilot requests and as the flight operations officer permits.... And all this goes on for months and even years, until tragedy occurs.

The number of serious mishaps and fatal accidents, which has increased lately, and their negative effect on the operational efficiency of the crew, subunit, and unit as a whole make flight safety an urgent issue, commensurate with maintaining combat readiness, ensuring effectiveness of operational training, assurance of the reliability of aircraft and weapons, the morale and political spirit of personnel, full adequacy of primary support services, stability of command and control, communications, etc. Accumulation of deficiencies and subsequent failure in any of these areas of functioning of flight operations (including flight safety) can nullify a unit's rated combat potential in the course of a specific operational sortie. Can this be ignored?

Status of Movie Extras

Appropriate service-providing organizations are prescribed for the purpose of achieving precise organization, a high degree of professionalism and stable command and control of units down through the echelons

and with feedback, for each of these and other areas, at all levels of the Air Force structure (from the administrative staff of the commander in chief of the Air Force down to the air regiment). Vertically they comprise a clear-cut core of a given specialization area, while horizontally they provide each commander with a coordinated mechanism of interaction of all flight service elements, be it a large strategic formation, a combined unit, or a unit (separate subunit).

How does the service which draws up for the Air Force one-man commander measures pertaining to accomplishing a task of national importance—ensuring flight safety—look within this structure?

While at the central administrative level the flight safety agency is represented by a service which, although with ranks considerably thinned in comparison with the past, is working not only for its own needs but also for the aviation components of the other branches of service, at the next lower levels—the army and division echelon—the Flight Safety Service is represented by only two or three officers, who are definitely too few in number to perform their principal function—organization and conduct of prevention activities in subordinate units.

A lack of check pilots for some air components, aviation engineer service specialist personnel (for fixed-wing and rotary-wing aircraft), and an aviation psychologist dooms this service solely to office administrative work, endless manipulation of numbers and examples, and copying lifeless statistics. A Flight Safety Service officer has neither time nor energy to determine hazardous factors and to teach pilots how to avoid getting into dangerous situations and the best corrective action.

An extremely negative effect is exerted both on effectiveness of the efforts of flight safety services at the division and higher levels, on their prestige and authority is exerted by the universal and deep-rooted practice of frequently appointing to flight safety work officers without career promise, who have lost any possibility of career advancement due to age, level of education, or state of health, or who have been transferred out of command assignments following infractions, air mishaps, or who were simply unable to do the job in their previous position. For all practical purposes many of them are fated to mark time serving out their years until retirement. One might ask where can we get for the flight safety services experienced officers with initiative and stick-to-itiveness, who would work selflessly both for the common cause and for their own personal career future?

The most harmful situation is the lack of flight safety specialist professionals in the air regiment. The fact that officers at the regimental command level are ignorant of the practical patterns and mechanisms of accident occurrence, lip-service planning and scheduling of flight safety activities, specialized training classes conducted in a superficial manner, frequently boiling down to staccato-paced reading of a large amount of information on subjects which are not relevant to the given regiment and air component, concealment of dangerous near-mishap incidents through the fault of personnel, and passing the buck whenever possible are all practices which engender complacency, unconcern, and overestimation of one's abilities. It is not surprising that after 18 months or two years of mishap-free operations this comes to an abrupt end—most frequently when shifting to complex types of flight operations or at an exercise, when there is a desire to display more performance than one is capable of handling. Particularly during the summer highest-frequency period of flying, when many supervisor personnel are on leave. This is well known to the people who investigate and study dozens of mishaps and fatal accidents, which are so similar to one another. But in many regiments, at airfields and ranges people forget about this and often know nothing about it. Such ignorance and such forgetfulness also lead to tragic incidents.

Should There Be A Flight Safety Service at the Regimental Level?

An air regiment flight safety service consisting of a pilot, an engineer, and the performance monitoring group will without question earn its keep, taking upon itself planning and scheduling functions, the conduct of training classes on the most important topics, and monitoring to ensure observance of regulations violation of which has fairly often led to air mishaps. Receiving training in specialized courses and periodically attending training conferences conducted by the higher-echelon services, these specialists will make a contribution in their own area of regimental support activities, helping commanders carry out their difficult job, reporting in advance on paramount preventive measures which are realistically possible on the basis of time and available resources, and personally taking part in their implementation. Regimental flight safety service officers should not be responsible for accomplishing the flight training plan. Only in this case will they be able effectively to block those commanders who attempt to meet the plan-specified target at any cost.

Some experience in flight safety service specialist activities has been amassed in Naval Aviation, where in some air regiments (which are not elements of air combined units) have for several years now had deputy commanders for flight safety. Of course this is not the best name for this position (air regiment flight safety service chief is unquestionably preferable). In addition, they work without an engineer-inspector. But on the whole this has had a positive effect on reducing the accident rate in these units. Promising officers with work experience as a squadron commander and who as a rule are subsequently promoted, are appointed to these billets. Officer V. Zhdanov, for example, deputy commander for flight safety of a Northern Fleet Air Forces separate reconnaissance regiment, following successful performance of his duties was made regimental commander, and subsequently commander of an air division, and was raised to the rank of major general of aviation.

One hears the view that the introduction of the position of flight safety service chief in the air regiment could on the one hand make this officer a scapegoat for violation of flight regulations, while on the other hand some regimental command echelon officers may cease any personal effort to ensure safety in their own areas of responsibility, considering all this the responsibility solely of the flight safety service officers.

Practical experience shows that such things do not happen with proper leadership on the part of the unit command element. Current standards-prescribing documents clearly state that the establishment of a flight safety service does not free command personnel from responsibility for ensuring flight safety within their areas of responsibility (subordination). In addition, it makes sense to evaluate the effectiveness of the job done by the regimental (as well as higher-echelon) flight safety service not on the basis of individual air mishaps (of course excluding incidents of personal errors of omission and oversights in the course of flight operations), but rather from the state and condition of flight safety over the most recent period (in comparison with the same period during the previous year) and according to decrease or, on the contrary, increase in the rate of reoccurrence of the same causes of hazardous situations and incidents, that is, they should be judged by the end result.

The advisability of adoption of air regiment flight safety services can be determined from the results of an experiment running through the course of a full training year in the units of two or three large strategic formations, as well as in the regiments of one air component of several large strategic formations. This certainly can be done without adding regimental personnel, by redistributing duties among the appropriate individuals.

It would be beneficial for leader personnel as well as all personnel of air units to take part in discussing these and other proposals and to help us find new ways to improve flight safety.

This can be done along the chain of command, as well as at appropriate meetings and training conferences, and in the form of responses to this article. One thing is clear: air unit personnel possess far from exhausted capabilities to prevent air mishaps. Let us work together seeking them out.

Problems With Flight Safety and Effective Combat Training

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[Article, published under the heading "Combat Training and Flight Safety: Viewpoints, Opinions," by Military Pilot 2nd Class Maj S. Goroshkin: "Disquieting Symptoms"]

[Text] Recently there has been noted in the press a rash of critical statements by flight personnel. There have been all kinds: from an appeal to topple the bureaucracy to a proclamation of immunity to normal rules and regulations and rejection of existing prohibitions in flight activities. As they say, things have been at a boil! And this is understandable. In the line units one pays with people's careers, and sometimes with people's lives, for inaccuracies and inexactitudes in the provisions of guideline documents, for organizational backwardness, and for lack of orderly regulation in job duties. For these people the stakes are too high to be able to discuss urgent problems in a cool and composed manner.

We should note that almost all articles were followed by constructive responses by leader personnel, and an article by Mar Avn A. Yefimov entitled "The Right to Make a Mistake" (AVIATSIYA I KOSMONAVTIKA, No 12, 1988) crossed the final t, it would seem.

They explained to pilots the objective essence of the factors which hold back training. But nevertheless one senses a kind of dissatisfaction with the replies. What is the problem? From where do these tendrils of doubt spring? Certainly nobody will argue against the need for precise observance of flight procedures and regulations or deny the mandatory need for conscientious performance of one's military duty. Apparently the point lies elsewhere.

Those authors who deal with practical activities directly or indirectly demand the division of responsibility, for nobody at any level made a clear-cut demarcation: where lies the culpability of the executants, and wherein lies that of the organizers? We shall cite an example which graphically illustrates the existing situation.

While on a landing approach in an Su-17, the pilot failed to extend his landing gear and ejected. The aircraft crashed and burned. In order to prevent the repetition of such occurrences in the future, the pilot was drummed out of the Armed Forces, and the flight operations officer was relieved of his duties. In addition, a landing gear observer was added to the air traffic control team.

Soon, however, a similar incident occurred. An aircraft commander failed to verify gear down, the flight operations officer failed to note this, while the observer claimed that he could see nothing from the control tower. Similar actions followed, with the difference that the landing gear observer was moved out and stationed by the middle marker. This required that he be checked on periodically, since as a rule he is a conscript soldier.

Thus the organization increased by one element and two operations, with a doubtful result and without a reliable guarantee of result. What kind of a conclusion suggests itself here?

In the first place, these measures have not resulted in achieving the objective. This is because the salient fact—that the pilot failed to lower the gear—was overlooked. They looked for the cause of the accident, but they found

a guilty party, which are two different things. From the standpoint of the regimental commander it may make sense to punish the pilot and flight operations officer for negligence, but from the standpoint of Air Force higher authorities it would have made sense to address the question of adding modifications to the equipment (additional display and warning devices, process automation, etc).

"Approximately 80 percent of air accidents occur due to unsatisfactory coordination of 'man' and 'machine' subsystems," claims Pilot-Engineer 1st Class Yu. Yakimov (AVIATSIYA I KOSMONAVTIKA, No 2, 1989). How can one in such a case condemn the executants? Are they violators or victims?

Secondly, when the air accident prevention system functions in this way: a deficiency is discovered (in our case failure to lower gear), rather than determining the cause they determine the organizational consequence (lack of attention by the pilot and the flight operations officer), and a compromise solution is proposed (landing gear observer)—one must expect serious consequences. Wherein does the danger lie here?

As we know, the more elements there are in a system, the poorer its reliability. Each newly-adopted element requires monitoring and additional expenditure of manpower and resources. Organization of flight operations becomes much more complex, awkward and unwieldy, while it does not become more effective or efficient. As a result it will become totally unsuited to accomplishing the Air Force mission.

One might ask why nobody bears responsibility for this? Where are our theorists who develop theory of functioning and development of the Air Force? How long are we going to rely on the rank-and-file Petrovs and Salimgareyevs for flight safety rather than on scientific conclusions? Are these really purely rhetorical questions?

Or take another example. Commanders and instructors are frequently reproached for failing to use an individual approach in training pilots. But what does this principle mean? According to the Combat Training Course it is a decrease or increase in the number of check rides, based on a pilot's ability. It would seem to be quite clear. In practice, however, if an air mishap occurs in conjunction with shortening of the training program, the primary finger of blame will be pointed precisely at this forcing of the pace of the Combat Training Course. And nobody will risk mentioning the pilot's individual qualities or personality type. At the present time there are no criteria at the level of official regulation which determine the manner of application of this principle in training.

This conclusion can also apply with full justification to the standards-prescribing approach in flight safety (AVIATSIYA I KOSMONAVTIKA, No 12, 1988). One can hardly call an approach a method if it has not yet assumed an actual place in organization of flight training. In addition, this fails to solve all problems even theoretically and should be viewed as a component part of methodology of ensuring flight safety. One must be clearly aware of the fact that a pilot's capabilities in performing a flight assignment do not constitute water level in a pipe but rather a complex function of many variables which are difficult to determine. In practice, however, our present standards are of little worth: it is not recommended to grade a maneuver sequence as "satisfactory," and it is dangerous to grade it "excellent," for this imposes considerable obligation. So all pilots receive marks of good. Are they to blame for this?

Today particular concern is aroused by stagnation in improving the combat and tactical proficiency of military aviators, which leads to deterioration of their professional skills. Frequently a veteran pilot who has logged hundreds of sorties becomes confused in a fairly simple situation or performs weapons delivery with a result barely meriting a positive mark.

Up to the present time there has existed the opinion that "the reasons for this phenomenon are a relaxation in the demandingness of commanders at various echelons, whose job it is to work constantly with those who have become a proficiency-rated pilot and to assign them new and more complex missions...." ("Lost Skill," KRASNAYA ZVEZDA, 3 July 1986). Let us endeavor to determine whether it is fair to level such serious charges against line-unit commanders.

First of all we shall see what is prescribed in the Combat Training Course for improving the military pilot's skills. Strange as it may seem, the principal guideline document suggests repeating the same drills over, with certain additional elements. How can one improve under such conditions?

Logic suggests that a uniform combat training course is needed, consisting, let us say, of three sections. The first section includes instruction in flying technique and combat flying (for pilot schools). The second covers mastering combat-mission flying and tactics (for air training centers). The third involves advanced flight and tactical training (for line units).

It is necessary to separate advanced training from primary and intermediate training for two reasons. First, these processes contain fundamental differences, and it is fairly difficult from an organizational standpoint to combine them. Secondly, at a certain stage in training, a pilot's experience enables him to depart from precise observance of the requirements of the prescribed method of certification or authorization to fly flight assignments solo or unsupervised. "There exists, as it were, a 'threshold of sensitivity' of military aviators' job-related activities to change in the conditions in which a task is performed.... The more experienced a pilot is, the less his performance results depend on external conditions" ("Is It Easy to Fly Wingman?" AVIATSIYA I KOSMONAVTIKA, No 1, 1989).

Even 300 hours of flight time logged makes it possible to alter a pilot's flight assignment across a fairly broad

range. But the paradox of the certification or authorization method lies in the fact that the slightest degree of autonomy takes away a guarantee of flight safety. At the present time there is no other proof of a pilot's ability to perform a maneuver sequence than the accomplished fact of a dual check ride covering that maneuver sequence. It is only this and nothing else that makes it possible reliably, within the framework of the authorization or certification method, to state what is greater: the level of a pilot's proficiency or the level of difficulty of the flight assignment.

This method fairly accurately, however, describes the training process. One can debate only the details here. For example, why not master new types of flying in six stages: dual instruction; initial training (check ride with check pilot); initial mastery (solo); determination and correction of typical pilot errors (with check pilot); basic mastery (solo); qualification check flight (check pilot).

It is another thing that proficiency-improving advanced training does not easily fit within the current method. The method does not permit ensuring steadily increasing complexity of flight assignments from one training sortie to the next. An incredibly large number of maneuver sequences would have to be specified.

The process of improving professional skills will be full-valued only on the basis of adoption of fundamentally new methods containing the maximum possible number of controlled parameters. This will make it possible to interpret tasks proceeding from already-mastered elements, and with a high probability of flight safety. It will be possible to devise a strategy of improving pilot proficiency in three principal areas: introduction of new elements or tactical moves into combat training, making conditions increasingly more complex, and gradual toughening of performance standards.

Having agreed with the presented arguments, it remains only to wonder why it is that in our Combat Training Courses, during the entire time of their existence, only the numbers of maneuver sequences and the sequence of performance of tasks have changed. As they say, the sum does not change when you change the position of the addends. To whose liking is such a constancy of result? I am convinced that it is to the liking of very few. A fundamentally new solution to the problem is needed.

All of us live under the influence of stereotypes. One might recall that the pilot training curriculums were initially devised for military flight schools. During that period the primary question was how to teach a person to fly and how to train a person in combat flying and weapons delivery. In time the combat training courses appeared in the line units, where the principal task should have been proficiency upgrading or advanced training. But since the flight schools did not accomplish and do not accomplish the tasks of full training, a significant portion of the work load of training flight personnel had to be assigned to the line units. To be objective about it, even today the air regiments and squadrons are reminiscent of flight school branch organizations, which are hard put to instruct, train, and check out their pilots. With this approach there can be no upgrading or advanced training in the true sense of the word.

It is inexplicable why advances in military aviation are occurring exclusively due to advances in aircraft engineering and arms manufacture, while restructuring of the organization of flight activities is being accomplished with enormous difficulty and cost, under the pressure of practical demands. And amazing in itself is the fact that until quite recently, when accidents would occur, air unit personnel would be made to engage in marching drill practice which, in the opinion of some commanders, was supposed to discipline people and prevent air mishaps in the future. But the future is implacable. Therefore many questions pertaining to flight safety are sometimes settled to the detriment of combat training by imposing restrictions, all-encompassing standardization, and excessive simplification of flight assignments. And this is not a consequence of subjective factors (errors and miscalculations) but is a logical result of the action of existing principles.

The thicket of numerous sweeping punishments of the immediate executing individuals conceals serious deficiencies in the combat training of military aviators, for frequently "successes" are achieved at great expenditures of manpower and resources and at the cost of extreme measures. The lack of objective criteria for evaluating the performance of persons in authority encourages a lip-service approach and actions geared to show and pretense and engenders indifference and irresponsibility. A person cannot be firm and principled in conditions where he is punished for that for which he is not to blame and is commended for that toward which he has not contributed in the slightest. Apparently this is the reason for the feeling of dissatisfaction on the part of flight personnel with replies in which it would seem that they have crossed all the t's and dotted all the i's.

Barnaul AF School Leader in Computer Training

90R90001G Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 12-13

[Article, published under the heading "Problems of Training and Indoctrination," by Lt Col V. Pozdeyev, senior instructor, Propaganda and Agitation Department, Air Force Political Directorate: "Great Benefit From 'Small Groups'"]

[Text] The active process of computerization of the labor of aircrews has brought an urgent need to raise the system of teaching future military pilots at Air Force higher educational institutions to use computers for practical applications to a qualitatively new, professional level.

The importance of this work is obvious. The administration and political section at the Barnaul Higher Military Aviation School for Pilots, where I studied the experience of organizational and indoctrination activities of the school's political agency and party organization in this area, are considering it not only from the standpoint of today's and tomorrow's requirements of air units for pilots with a mastery of the skills of using computers in the air and during ground training. They realize that this is a part of a nationwide task, involving the entire party, to accomplish extensive adoption of computers in all domains of science, production, and education, and to boost the computer literacy of Soviet citizens.

In publicizing and implementing the party's program guideline, the school's political section and party organizations rely on party members—department heads, teaching faculty, and electronics specialists, who include many genuine enthusiasts of computerization and innovators in education science and practices.

Candidate of Physical and Mathematical Sciences Maj I. Levkin, senior instructor in the department of avionics, often begins classes with a statement made by Academician Ye. Velikhov to the effect that a person at the end of the 1980s and beginning of the 1990s who does not know how to program will be like a person at the beginning of our millennium. This instructor forms in his students a serious, responsible psychological attitude toward the study of computers.

Of course every instructor has his own techniques and methods of heightening his students' interest in the subject, but I believe that in this instance the officer's example serves as perhaps the strongest mobilizing factor. Major Levkin falls within that category of persons whose dedication to their beloved cause borders on total, overwhelming commitment, and his enthusiasm is so infectious that it simply cannot help but spread to those around him.

No less impressive are the results of Igor Vasilyevich's practical activities. With his active participation, a specialized computer classroom has been established at the school, training curricula have been developed, and instructional manuals have been published. As far as I know, at the present time the Barnaul Higher Military Aviation School for Pilots is ahead of all our other flight schools as regards instructional facilities, organization and quality of cadet computer training. Behind this one can see enormous work on the part of the faculty of the department of avionics, including Maj I. Levkin as one of the leading computer specialists.

Igor Vasilyevich came to the school several years ago, at the height of innovator enthusiasm in education science. The methods of Shatalov, Amonashvili, Shchetinin, and other scientists and practical experts who are well known and little known to the general public stirred people's minds and hearts. Many were seized by the urge to experiment. Levkin also saw and felt the need for refurbishing education science "from top to bottom," but then the analyst in him prevailed over the romantic. He realized that, with his meager teaching experience and methodological expertise, an attempt to strike out on his own path could lead to a dead end. He therefore proceeded with a comprehensive effort to form his arsenal of pedagogic tools "while continuing full-time gainful employment."

An innovative attitude toward the experience and know-how of his colleagues as well as his own, as well as consideration of the specific features of his youth audience, the cadets' interests and desires helped Major Levkin in time elaborate his own concept of teaching information science and computers. I would call it pedagogic collaboration.

This concept is an example of application of the Leninist principle of democratic centralism in the "technology" of training and instruction. Schematically it consists essentially in a transition from a subject-object to a subject-subject type of learning. In practice this means comprehensive development of democratic principles in the pedagogic process and the transformation of management of this process to self-management. Handing over some control functions to the students, the instructor—the center—retains the role of linking and guiding element and consultant. This system promotes an appreciable increase in the cadets' autonomy and creative activeness and, in the ideal, aims at reaching the level of self-instruction and self-indoctrination.

The future pilots displayed an enthusiasm characteristic of youth toward the changes initiated by Major Levkin. His classes, especially the practical hands-on classes, rapidly gained in popularity. Practically everybody became enthusiastic over programming. Many cadets who were successfully mastering the computer asked the instructor to make the problems more complicated and not to limit things to the course material. The number of such cadets was growing, and Igor Vasilyevich came to the conclusion that it was necessary to divide the class groups into subgroups containing young men with approximately the same level of computer training.

Computer time was allocated to each subgroup, and class performance results were monitored and recorded, with performance used to determine the subgroups' place within the subunits and within the overall class. This made classroom learning more competitive, strengthened a collectivist spirit, and fostered development of independence and responsibility on the part of the young aviators. The cadets themselves divided up computer time and work stations and kept record of learning progress. The groups developed self-management in this manner. Differentiation and individualization of the instructional process created favorable conditions for increasing student interest in the subject and realization of the cadets' abilities.

On numerous occasions I attended classes and open classroom activities and heard Major Levkin note with pride, on presenting a group to his colleagues or visitors to the school: "Here we have second-year cadets who are already writing computer programs on their own, and many are even faster at programming than their instructor!"

"So what?" Igor Vasilyevich's more touchy colleagues shrugged their shoulders. "In our classes the cadets are also successfully coping with their lesson assignments...."

I don't mean to insult anybody, but a comparison at this time would not be to their advantage. The work intensity, difficulty of the assignments, and their innovative nature are higher by a full order of magnitude in Levkin's groups. This is a fact, and I would call the system of instruction employed by this teacher an "actively developing" system.

What attributes of cadet self-management does Igor Vasilyevich consider to be the most typical, and in his opinion does self-management constitute one of the most vivid manifestations of democratization of the process of instruction and indoctrination at the service school?

"Cadet self-government already genuinely exists in our class groups, is further evolving, and is producing results. For this reason it is a waste of time to debate the point on whether or not self-government exists and whether or not it is a consequence of democratization of instruction or vice versa, an attempt to avoid the main issue: should self-government be recognized or should it not?"

And why not recognize it if self-management is not in conflict with the fundamental principles of education and science? Partial redistribution of functions between instructor and students in the interests of developing the cadets' independence and creativity by no means violates the canons of education science; it is merely one variation of improving the "technology" of the curricular process.

Since the cadet groups comprise an aggregate of interlinked separate class subgroups, the form of learning employed in our department has been dubbed "didactic system of 'small groups'." Self-management is today inherent in this system to the greatest degree....

Among typical attributes of self-management Maj I. Levkin notes the specific and effective mutual assistance by the cadets in the "small groups" in mastering the computer, as well as increased group responsibility for the quality of learning, high productivity and better organization of independent study, and other advantages of conscientious, responsible, innovative activity.

We should note that Levkin by no means considers his system ideal and is constantly working on improving it. This officer's commitment and dedication to this work cannot but evoke sincere respect and faith in his success.

Three years ago the Barnaul cadets, after completing the information science and computer course, pretended that they knew the subject, while the instructors pretended to have faith in their knowledge. Today the situation has changed radically. A certain level and quality have been achieved in computer-training future military pilots, making it possible to utilize computers effectively in the curricular process and to lay down a foundation for the graduates' subsequent work in line units. This is without question an appreciable step forward. And considerable credit for this must go to Maj I. Levkin, his comrades, and administrators in the department of avionics and the school as a whole.

At the same time the united efforts of instructors, computer specialists and cadets, as well as existing facilities could be more beneficial both to the school and to the Air Force as a whole.

What is the point here? The point is that experience indicates that sometimes as much as 100 hours of work time is spent on developing just one teaching or testing program. In conditions where computerization of the curricular process at higher educational institutions is becoming reality, it would be possible to save a considerable amount of time, facilities and computer time if a unified data center or data bank were established, for computer programs have long since become a commodity which can be exchanged, purchased, and sold. Many electronics specialists with whom I have talked believe that the Air Force Directorate of Military Educational Institutions could serve as an organizer of such activities in the interests of efficient utilization of the schools' scientific and creative potential.

Resolution of this problem is closely linked with another—development and implementation of a plan for new, common training facilities for Air Force flight schools. The fact is that today all work being done on computerizing the curricular process, developing specialized classrooms, and raising the level of people's computer literacy is in large measure of a volunteer nature and is being carried along on the enthusiasm of administrators and specialists like Igor Vasilyevich Levkin. But this cannot continue forever! This important activity needs a solid scientific, organizational, and facilities foundation.

Here is one of the paradoxes of our time: the cost of training an engineer-pilot is two times that of training a civilian specialist with a higher education. Higher educational institutions in the kray administrative center are much better equipped with computer hardware than the Barnaul Higher Military Aviation School for Pilots.

For the time being we are succeeding in compensating to some degree for our poverty with better organization of the curricular process and by using efficient methods, as is persuasively shown by the experience of Maj I. Levkin and Lt Cols V. Yakovenko, S. Terletskiy, V. Sharapov, V. Maksimov, and M. Paseka, Capt A. Brants, and other Barnaul computerization enthusiasts.

But they are not standing around idle at civilian higher educational institutions! In order not to fall behind in level and quality of computer training for flight personnel, we must find the ways and means to provide service schools with sufficient quantities of modern computer hardware. I believe that it is important to ensure that computers are of a single, compatible type. Improvement of the curricular process could also be promoted by practical adoption of the existing Focus software system, at the interactive-mode level, that is, adoption of a dialogue method making it possible to conduct textual information exchange.

These thoughts and suggestions came to me as a result of the Barnaul experience, substantial and useful experience which merits words of praise. Levkin and his comrades needs words least of all, however—what they need is specific, constructive help in accomplishing tasks which already today in large measure determine and tomorrow will to an even greater degree affect restructuring processes in the Air Force.

Suggestions For Improving Flight Technician Training

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[Article, published under the heading "A Reader Asks," by Senior Flight Technician-Instructor 2nd Class Capt V. Soroka: "Both Accountability and Help Are Needed"]

[Text] We might recall the shopworn expression: "The crew chief [airborne flight technician] Is the aircraft's master." But is that actually the case? What is the present status of this category of Air Force personnel? The current relevance of these questions proceeds, I would say, from the unique status of the bortovoy tekhnik ["flight technician"—crew chief], the job of whom is situated at the juncture of literally all ground and air services.

What tasks is the flying crew chief called upon to perform in the air and on the ground? They can be arbitrarily divided into two groups: ensuring intelligent operation of the aircraft in flight, and rapid detection and correction of malfunctions and physical damage on the ground (often covering all maintenance specialization areas when servicing an aircraft at an airfield away from one's base).

Practical operations and maintenance experience indicate that these tasks are sometimes performed in a not very high-quality manner, including through the fault of members of our service. In emergency situations some specialist personnel display technical incompetence and ignorance of regulations on crew response in emergency situations, are unable to suggest to the aircraft commander a solution in a given emergency situation connected with equipment failure, and sometimes even worsen the situation by their own faulty actions. It also sometimes happens that flight technicians themselves do a poor job of operating or maintaining the equipment, which leads to serious malfunctions during flight.

Nor does everybody perform skillfully on the ground. Frequently they are unable quickly to determine a problem based on symptoms, and they display poor knowledge in the area of adjacent or related military occupational specialties.

What is the problem? Why is it that the "masters" are not always able to put their "house" in order? In my opinion the cause lies primarily in the fact that flight technicians are essentially left to their own devices.

Aircraft operation and maintenance practices have confirmed the correctness of organizational subordination of aircrew members to different services: flight, navigation, communications, gunnery, and aviation engineering. This makes it possible to train and test the proficiency of specialist personnel in a differentiated manner, quickly and efficiently to communicate to them changes in guideline documents and jointly to study such changes, and to disseminate advanced know-how in the various specialization areas. But of all the crewmembers, only the flight technician is subordinate to a service chief, which in my opinion makes sure that they perform what is not their main task.

The deputy commander of an air squadron for aviation engineering service can say little to the airman about aircraft equipment operation in flight, due to the specific features of the flight technician training program. All hopes in this regard are placed solely on the flight technician-instructor. But the aircraft's "master" is not subordinate to him.

Just who teaches the flight technician and trains him to respond to emergency situations, and how does he accomplish this? During in-flight training with instructor (approximately 30 hours), he is taught by an experienced flight technician-instructor. Subsequently, usually after a newcomer has made some mistake during a flight, he is instructed by crew members. For the most part this involves nothing more than a peremptory command to do it right, with no intent to instruct by explanation, and rarely is he given the opportunity to take part in a training drill aboard. Unfortunately, as a result we end up learning from our own mistakes and from the sad experience of our comrades, which is usually disseminated in the form of rumors and instructive tales, but it is in no way reflected in regulations and training manuals. The most conscientious and highly-disciplined flight technicians generally study at home, on their own time. And as always, there is an acute shortage of such time available.

We have no real flight technician training course or curriculum, that is, a training program provided with scheduled hours, instructors, and scientifically-substantiated curriculum. This also makes it difficult to determine whether they are ready to earn a higher

proficiency rating. At the present time we employ a rather simple system: in order to take the test for 2nd class you have to fly for three years, five years for 1st class, and 10 years for the master proficiency rating. These requirements more describe a candidate's age than his qualifications.

The flight technician does not deserve to be treated in this way.

We know that a well-trained specialist is capable of preventing a mishap involving malfunctioning or ignorant operation of aircraft equipment, of detecting in advance and correcting any problems which crop up in the aircraft he knows so well. The design engineers are convinced of the greater reliability of aircraft with flight technician and flight engineer crewmembers and keep these personnel even when reducing aircrew because of greater incorporation of avionics gear.

Obviously sooner or later it will be necessary to detach this category of aircrew members off into a separate service, on analogy with the navigation service, and to establish a special combat training course curriculum of a new type, and begin a planned and orderly process of raising the proficiency level of flight technicians.

It seems to me that the Combat Training Course should contain drills enabling aircraft "masters" to improve their knowledge and skills in performing their direct duties. They should be performed on the ground, in simulators, and in the air, in the presence of an instructor who is also a superior.

At the first stage it would not be a bad idea to simulate simple aircraft system failures and to test the individual's response to correct them, in due course moving on to more substantial "failures" and "malfunctions." Subsequently the list of drills can be supplemented with actual problems which have occurred in flight on aircraft of the given type, arranged in order of increasing difficulties.

The second part of the training course is envisaged as a set of exercises which gradually lead specialist personnel to the height of proficiency in preventive maintenance inspection and correction of aircraft equipment malfunctions on the ground. In the first phase, for example, they could perform procedures involving correcting minor problems, such as replacing wheels within the standard allotted time. A performance mark would be entered into a special section of the crewmember's logbook. Subsequently the difficulty of procedures would increase: taking part in replacing props, engines, supervising engine replacement, and engine tuning. These procedures can be monitored both by a flight technician-instructor and by other aviation engineering service supervisors.

With this system the specialist himself will be concerned, when taking the tests for 1st class, for example, with replacing and tuning an engine. Thus a flight technician's proficiency rating will reflect his amassed experience rather than his time in grade, which would increase the prestige of a proficiency rating, I would think.

Troubleshooting and preventive maintenance inspection could be handled in approximately the same way. At first simple malfunctions would be simulated, followed by the introduction of "failures" into aircraft systems and, finally, the technician would work on skills of detecting malfunctions based on an aggregate of direct and indirect symptoms. The main condition for effectiveness of performance in such practice drills should be authenticity of scenario: the trainee does not know what has happened in the system, but he should find the problem, determine the cause, and correct it. If the pilot has erred, the flight technician should tell him what to do and how to do it.

I believe that organizing flight technicians into a separate service will help find time to train specialist personnel on a training course curriculum. Toward this end, their participation in preliminary preparation should be reduced. There is no need for this specialist to remain aboard and wait for his comrades to finish repairing the same piece of ground equipment. The time which has been freed up, which will be substantial (if a clear-cut delineation is made between the duties of flight technicians and ground technicians), should be devoted to activities as discussed above.

I feel that the theory training curriculum for flight technicians should also be revised: they should learn more about aircraft equipment as well as electronic equipment. Weak spots are most frequently noted precisely in this area. Technicians should have more information on the features of working with specialized equipment, airfield technical support equipment, and POL. We encounter all this on a daily basis, and yet we are short on systems knowledge.

I feel that it would be more effective to train a flight technician on a specific aircraft in specialized training courses attached to an engineering military higher educational institution or design office. The cost of setting up such training programs would be repaid a hundredfold. At worst such a program could be limited to intensive training at least for flight technician-instructors.

I would like to see in a new Manual of Flight Operations an article which formally authorizes a flight technician to prohibit, on the basis of technical condition, an aircraft from taking off from an airfield away from its home base, for no other crewmember knows better than him the condition and state of the aircraft.

Here is another important item. A flight technician is a technical specialist, who studies and evaluates in a professional way the strong and weak points of an aircraft's design and construction. His comments, based on knowledge gained through hard work, would be useful for the representatives of scientific research institutes, design offices, and the Ministry of Aviation Industry, but the road to such high echelons is long. A lack of feedback

leads to paradoxes, where an aircraft's capabilities and the requirements as specified in the operating manual are conflictive and contradictory. Why shouldn't we establish a direct exchange of views with the authors of these puzzling recommendations and engineering decisions, using get-togethers, conferences, or via some kind of informational publication? The common cause could only gain from this.

Combat operations experience indicates that a flight technician should at least receive a minimum of flight training as well. In an extreme emergency he could replace one of the pilots. And in my opinion he is capable of doing this better than any other crewmember.

What has been stated in this article is of course subject to debate. But these issues must be resolved. Particularly since almost all of them are of an organizational nature and do not require substantial material outlays. And it would seem that the benefits would be quite tangible—improvement in the quality and effectiveness of flight operations and operational readiness of Air Force units and subunits.

History of Soviet Manned Space Program

90R90001I Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 20-23

[Article, published under the heading "History of the Space Program," by Col V. Gorkov: "Resident of Startown"; part one of two-part article]

[Text] A CPSU Central Committee and USSR Council of Ministers decree dated 5 January 1959, dealing with biomedical preparation of humans for space flight, can be considered the first document reflecting the intention to establish the Cosmonaut Training Center. Precisely this decree made the experts give thought to the question of what profession would likely contain potential cosmonaut candidates.

In the opinion of the medical people, the first space explorer should be a doctor; after all, history contains numerous examples of doctors risking their own life to save patients. In 1956, when Sergey Pavlovich Korolev, following a series of biological experiments carried aboard geophysical rockets, stated the idea of sending a man into suborbital flight, doctors were the first to throw support behind his idea. Statements from A. Genin, I. Kasyan, A. Seryapin, Ye. Shepelev, and Ye. Yuganov were placed on his desk.

At that time space engineers did not possess much experience, but nevertheless they were designing the first space vehicle and were more familiar with it than anybody else. And of course many of them were dreaming of testing it out in space. The Chief Designer was also thinking about this.

Their dream would ultimately come true, but at that time fighter pilots proved to be better prepared than anybody else for space flight. Flying at high altitude in special gear, they were acquainted with G loads and hypoxia, and they knew how to parachute. In addition, a fighter pilot more frequently encounters situations causing great emotional stress and requiring speed and precision of reaction, volition, boldness, ingenuity, and purposefulness. He is familiar with theory of flight, he knows control, performance, and navigation instruments, and he knows how to work with communications gear. This is why the decision was made to train fighter pilots as the first cosmonauts.

But who should train the cosmonauts? Doctors, of course, since the question was whether man could live in space. In addition, doctors had been working on this problem for years.

I would like to recall Vladimir Ivanovich Yazdovskiy. He not only had an early involvement with the biomedical problems of manned space flight but was also the first person in this country to begin finding a practical solution to them. We read on the certificate accompanying the gold medal given to him as an International Academy of Aviation Medicine awardee: "To Professor V. Yazdovskiy for his unique experiments, which validated the possibility of manned space flight, and for successful accomplishment of the first manned missions."

At the end of 1948 A. Tupolev introduced Vladimir Ivanovich to S. Korolev, who asked him to conduct rocketborne medical and biological research. The final decision was made with the blessing of Aleksey Vasilyevich Pokrovskiy, head of the institute at which Yazdovskiy worked. Working jointly with V. Popov, and later with A. Seryapin as well, he proceeded to draw up a long-range research program involving representatives of the animal world. Equipment to record and monitor their physiological state and habitat environment, as well as a recovery system (ejecting vehicles, pressure suits, parachutes) were developed and tested aboard geophysical rockets. Amassed experience and research results made it possible to proceed without delay with experiments during orbital flight. Layka was boosted into orbit just one month following the launch of the first manmade satellite.

"The Americans were so stunned," Vladimir Ivanovich related to me, "that at first they refused to believe that we had actually done it. Only after Layka's electrocardiogram was recorded both in the United States and Japan were the experts across the ocean finally forced to acknowledge that this was a momentous flight."

Thus the Institute of Aviation Medicine was during those years the center for scientific and applied research on this problem. This is why the commander in chief of the Air Force in August 1959 assigned the task of screening and selecting cosmonaut candidates precisely to this institute and to the Central Aviation Scientific

Research Hospital. A team was formed at the institute, made up of V. Yazdovskiy, N. Gurovskiy, O. Gazenko, A. Genin, and other specialists. They are the ones who developed the method of cosmonaut candidate screening and selection. Representatives of this group subsequently went out into the field to visit line units.

The assignment was so important that the travel authorization documents were signed by the chief of the Main Staff of the Air Force. The commanding officer of the air division was the only person told the purpose of the visit. At the screening and selection sites the board first examined the officers' medical records, and then called in for an interview those who successfully passed this screening process.

"The conversation had nothing whatsoever to do with space," recalls Nikolay Nikolayevich Gurovskiy. "Some officers had no idea what we were getting at and why we had come, while others on the contrary got the point immediately and asked permission to consult with their family. We had to absolutely forbid this: it was a new, top-secret project, and the prospect had to make the decision himself, without outside assistance."

More than 200 out of several thousand persons were selected for further medical examination at the Central Aviation Scientific Research Hospital. A team of doctors at the hospital, led by A. Usanov, devised a cosmonaut candidate screening, selection and examination program. F. Gorbov, I. Bryanov, M. Vyadro, and Ye. Fedorov took active part in this period. A central medical board examined the results of the screening and selection process. It was to select 20 candidates. Those were the orders. All those who passed the screening and selection process were sent back to their units to wait until they were called.

At the end of February 1960 12 persons came to the Central Aviation Scientific Research Hospital for additional medical examination: Capts V. Komarov and P. Popovich, Sr Lts A. Anikeyev, V. Bykovskiy, B. Volynov, Yu. Gagarin, V. Gorbatko, G. Nelyubov, A. Nikolayev, G. Titov, and G. Shonin, and Lt A. Leonov. On 7 March they were greeted by Chief Marshal of Aviation K. Vershinin. Following a speech which could be characterized as parting words prior to departure on a long, difficult journey, each received written orders: they were instructed to return to their unit, settle affairs there immediately, and proceed to the Cosmonaut Training Center. On these orders they saw for the first time the signature of N. Kamanin, a person with whose name their career would be linked over the course of the next 10 years. The remaining eight members of the cosmonaut corps arrived somewhat later: Sr Lt Ye. Khrunov on 9 March, Maj P. Belyayev on 25 March, Sr Lts V. Bondarenko, D. Zaikin, and V. Filatev on 25 March, and Sr Lts V. Varlamov, A. Kartashov, and M. Rafikov on 28 April.

Training for and performance of manned space flight is a twofold task, accomplishment of which depends both on the individual involved and on the equipment used for training. What was the status at that time of development of a manned spacecraft and simulators?

Development of a deorbit propulsion system was the most difficult problem in developing a spacecraft. Although there was at least some experience with other systems, methods of returning from orbit were totally unknown. Even the very approach to igniting a rocket motor in conditions of weightlessness, when in the propellant tanks there is no clear boundary between liquid and gas, presented a highly complex problem at that time, for fuel lines should not contain even the tiniest gas bubbles. By May 1960 the A. Isayev Experimental Design Office had developed a manned spacecraft deorbit propulsion system, and three months later the first living beings—the dogs Belka and Strelka—returned safely to earth.

But would a human being be able to withstand such an ordeal? K. E. Tsiolkovskiy noted in his writings that spatial orientation confusion can occur during weightlessness, as well as dizziness connected with change in the functions of the vestibular system, and disruption of coordination of movements. This scientist had no doubts that man would be able to adapt to living in an "environment without gravity." He also pointed out that changes could occur in the behavior, structure, and functions of the living organism during an extended stay in weightlessness, changes which satisfy, to use his expression, "the ideal of the new environment." All these points of theory, however, had to be tested.

Scientists proposed various means of creating weightlessness in terrestrial conditions using test-bed facilities. These were rejected, however, for many reasons. Using aircraft appeared more feasible. A special dual-seat fighter flight path trajectory was computed, which would put the pilot and the test subject in a state very close to weightlessness, although only for a brief time. A MiG-15 fighter trainer with a specially-equipped cockpit was prepared for training the first cosmonauts. The cosmonaut's behavior was recorded on motion-picture film, and certain of his physiological parameters were also recorded.

In addition to weightlessness, no less a hazard was presented by solar radiation and the radiation belts, discovered in 1958, as well as the danger of meteorite strikes. These could not be simulated on the ground, and therefore in this matter the design engineers and medical people relied primarily on the scientists' theoretical calculations. A special pressure suit and a life-support system were developed for the cosmonauts. The ventilation-type pressure suit consisted of three envelopes or layers. The outer one took the stresses caused by creation of overpressure in the spacesuit. Under this was an airtight layer or envelope and an insulated suit with a ventilation system. The cosmonaut donned outside all this a nonfunctional orange suit with a flotation collar. The pressurized helmet had a double-paned visor.

A thorough study was made of the question of the position of a cosmonaut's body in the space capsule during boost into orbit and descent from orbit, for space flight would involve not only weightlessness but also very high G-loads. And aviation experience indicated that substantial G-loads can exert an adverse effect on the system. Conducted studies made it possible to determine the optimal angle of body position to the load factor vector. Thus it was established that a human being is capable of withstanding a 26.5-fold increase in the weight of his body. Special centrifuge training was provided for the cosmonauts in order to become more closely acquainted with the G-loads during space flight.

In addition to protracted G-loads, a cosmonaut would also be subjected to brief, so-called shock load factors. They occur, for example, when the cosmonaut's ejection seat is "fired" during descent in the atmosphere. Test engineers worked on these problems on MiG-15 and MiG-17 aircraft. This project was culminated by an ejection with the subject wearing a cosmonaut pressure suit. This was an aviation first. The ejection technique was developed on a specially-equipped Il-28 aircraft. The ejection and explosive-charge devices built into the seat enabled the test engineer to eject at an altitude of 7,000 meters. The drogue chute released 3,000 kilometers lower. At this point the main chute was deployed. The test engineer, separating from the ejection seat, descended the rest of the way by parachute.

Thus step by step, at various Soviet enterprises, specialists prepared the equipment and simulators for the first manned mission. Establishment of the Cosmonaut Training Center was proceeding in parallel with the work being done by designers, engineers and test personnel. Training center staff and organizational timetable were specified on 11 January 1960 by a directive issued by the commander in chief of the Air Force. The head of the Cosmonaut Training Center was to be the principal figure in this new undertaking. There were several candidates for this position, but the final choice was Yevgeniy Anatolevich Karpov, a doctor from N. Gurovskiy's department. He was appointed to this position on 24 February 1960, by order of the commander in chief of the Air Force. Young and energetic, with intellectual breadth, he readily found common ground with others. All these qualities helped him subsequently withstand the rigors of the difficult position of first head of the Cosmonaut Training Center and helped lay down the foundation of the now world-famous Startown [Zvezdnyy Gorodok].

Named as his deputies were political worker Nikolay Fedorovich Nikeryasov, Yevstafiy Yevseyevich Tselikin, director of flight training, Vladimir Vasilyevich Kovalev, head of the training section, and Anatoliy Ivanovich Susuyev, head of the logistics section. The cosmonauts' first instructors were medical doctors V. Yazdovskiy, A. Genin, O. Gazenko, N. Gurovskiy, A. Seryapin, and F. Gorbov, specialists from the Korolev Design Office B. Raushenbakh and K. Feoktistov, Honored Master of Sport USSR parachutist N. Nikitin, and physical training specialist B. Legonkov.

Training classes commenced on 14 March in Moscow, in a two-story building on Leningradskoye Shosse, by the city air terminal. In April the cosmonauts flew to Saratov for parachute training. The specific features of cosmonaut training required that the Center be moved from Moscow to a more tranquil location. Institute deputy head Vasiliy Yakovlevich Klokov, who at that time was supervising the Center, was instructed to handle this task. Two possible sites were considered: one at Balashikha, and the other near the present-day Tsiolkovskaya rail station. The commission felt that the latter site was preferable. They were won over by its isolated location, the vast size of the practically empty site, which was sufficient to meet any future needs, the proximity to highways and rail lines, proximity to the Korolev Design Office, and the possibility of initially housing employees and cosmonauts in an apartment complex on Chkalovskaya.

There was also another factor favoring this site. The fact is that the site had been transferred over somewhat earlier to the Ministry of Defense for the purpose of establishing on the site a post for a military unit. This plan had subsequently been abandoned, but woodland on the site had been cleared, temporary housing for the construction workers was still standing, foundations had been laid for several buildings, and there was an uncompleted two-story building on the site. Of course there were no prospects for further construction on the construction-started buildings, but the fact that the basic site preparation had been completed was to everybody's liking. In order to understand this fact, one must consider the situation at the beginning of the 1960s. Every ruble counted in those years—years of rebuilding of the economy from the wartime devastation.

The Center moved out into Moscow Oblast on 29 June 1960. The new community was called Zelenyy [Green]. **(To be concluded)**

Military Personnel Legal Questions Answered

90R90001J Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) p 27

[Article by Col Justice S. Kuznetsov: "Legal Consultation"]

[Text] **In connection with the period of regular annual leaves which is now commencing, we publish replies to questions asked by our readers.**

* * *

Capt O. Roshchin: I am stationed in the Ukraine and would like to spend my annual leave in Vladivostok. Can they turn me down with the excuse that I have no relatives there?

Reply: Regular leave shall be given during the course of a calendar year to officer personnel, with the exception of personnel who receive permission to combine two years' regular annual leave. An officer may spend his leave anywhere in the country, with no restricting conditions.

Sr Lt P. Voloshchuk: During leave I injured my leg and received medical treatment for a week. How am I to be compensated for these sick days?

Reply: For military personnel who fall ill during their regular annual leave, leave following recovery shall be extended by the number of unused days. In this case extension of leave is arranged by the appropriate commanders and superior officers on the basis of a notarized document bearing the signature of the treating physician and the head (chief physician) of the medical establishment.

Lt Col V. Nesterov: I wanted to spend my leave together with my family, but the organization in which my wife works turned her request down. Are the wives of military personnel entitled to take vacation at a time which is convenient for them?

Reply: Vacation for workers and employees is taken according to a schedule prepared by management in agreement with the enterprise trade union committee. No special privileges are provided for the spouses of military personnel.

Maj I. Bubenets: Must military personnel take their entire regular annual leave in one lump amount?

Reply: In order to improve state of health and achieve full utilization of regular leaves, and in order to increase combat readiness, general officers, flag officers, and other commissioned officers more than 60 years of age, as well as those less than 60 years of age who qualify by reason of state of health, who have served 25 years or more in the USSR Armed Forces, are entitled to break their regular annual leave into two parts, taking part in the summer and part in the winter period. In addition, Air Force and Navy flight personnel, regardless of age and years served, may break their regular leave up into two parts, with the bulk of the leave (25-30 days) used for organized rest and recreation, and with the second portion of leave spent as the individual sees fit.

Therapeutic rest facilities shall be used for short-term, 7-10 days, active rest for flight personnel, for the purpose of restoring an individual's professional work fitness and preventing fatigue. In exceptional cases air traffic control/flight operations officers may be sent to therapeutic rest facilities.

Time spent at a unit therapeutic rest facility shall not count as part of regular annual leave.

Officer's wife M. Dubinina: Under what conditions can I use my husband's military travel documents?

Reply: The USSR Ministry of Defense Military Travel Procedures Guide and procedures of payment for military travel adopted by order of the USSR Minister of Defense specify that for officers, warrant officers, extended-service personnel and female military personnel, one family member is entitled to travel on military travel documents in the current year, when traveling together with the member of the military or separately to and from the selected vacation destination, if in the preceding year the member of the military did not use military travel documents to travel on his regular annual leave. In addition, even if the wife or other member of a serviceman's family has already used in the current year travel documents issued to them personally for travel to a sanatorium, rest house, or vacation facility, they are entitled to utilize travel documents which were unused by military personnel in the previous year.

Peculiarities of Su-24 Fencer Hydraulic System

90R90001K Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 28-29

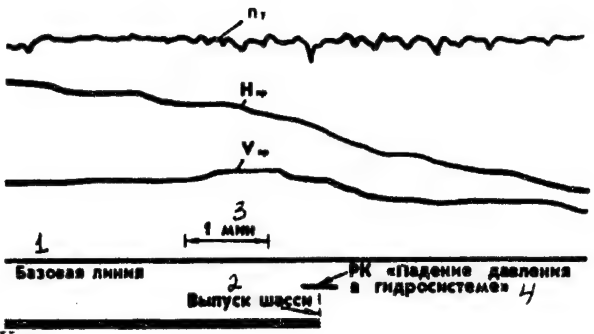
[Article, published under the heading "Putting the Recommendations of Science Into Practice," by Lt Col B. Shafarenko and Lt Col Yu. Peshkinev, senior engineer, Yeysk Higher Military Aviation School for Pilots: "Pressure Drop in Hydraulic System...."]

[Text] An Su-24 combat trainer aircraft, being flown by Lt A. Ivanov, was on a landing approach. Instructor pilot Maj V. Kovalev was closely monitoring his actions as well as the instrument readings. "Extending gear," the lieutenant reported, and placed the landing gear selector in the gear down position. At this instant a danger warning light flashed on and a warning message flashed on the annuciator panel: "Check Hydraulic System Pressure." Both pilots noticed that hydraulic system pressure had dropped below 18 MPa, that is, out of the green. But their response differed.

Major Kovalev, who has logged a great deal of time in aircraft of various types, was not alarmed by the situation. He knew that a low pressure warning during gear extension was a peculiarity of this type of aircraft. This is noted both in the aircraft operating manual and in the aircraft technical data. Figure 1 shows a section of a record on a data recorder tape showing the triggering of the annuciator panel warning message "Pressure Drop in Hydraulic System."

Lieutenant Ivanov had only recently begun mastering this aircraft and for that reason was concerned about the pressure drop. In spite of the fact that pressure returned to normal after a few seconds, after landing he decided to look into the physical details of the processes which take place in the hydraulic system during landing gear extension. For this he read through once again the Hydraulic System section of the manual containing a description of

Figure 1. Section of Data Recorder Tape Record Showing Triggering of Annuciator Panel Warning Message "Pressure Drop in Hydraulic System" during extension of landing gear in flight. n_y—normal load factor; H_{np} and V_{np}—normalized altitude and airspeed.



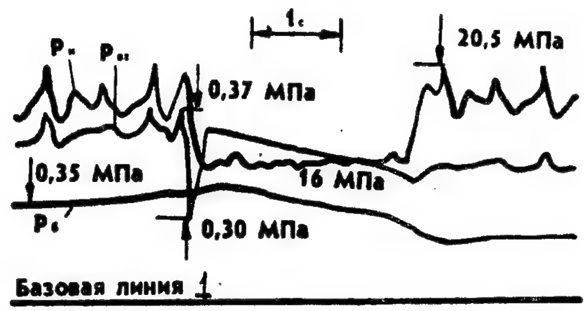
Key:
1. Base line
2. Gear extension
3. Minute
4. Triggering of annunciator panel warning message "Pressure Drop in Hydraulic System"

the airplane and its systems, and he also talked with veteran aviation engineering service specialist personnel. He was also assisted by a member of the staff of an aviation scientific research institute who happened to be visiting the unit.

First of all it was determined that when the gear selector was switched to the extend gear position, there occurred, as was normal, practically instantaneous opening of the main to apply hydraulic fluid to the retracted gear locking mechanisms in order to open these mechanisms, and to the gear extension actuating cylinders. As a result pressure began to drop in the hydraulic system delivery line. But the pump, attempting automatically to maintain pressure, increased hydraulic fluid flow into the system. This resulted in a pressure drop at the pressure pump inlet, since it had begun drawing in hydraulic fluid more intensively. An oscillograph trace (Figure 2) shows the nature of change in pressures in the hydraulic system.

Through joint efforts he also succeeded in elucidating some highly interesting peculiarities about which practically nothing was said in the operating and servicing documents. It seems that in the hydraulic fluid supply tank the gas which applies pressure to the hydraulic fluid dissolves in the fluid up to a certain state, which is called an equilibrium concentration. When pressure drops, the gas dissolved in the hydraulic fluid begins to separate out as bubbles until the onset of a new equilibrium phase corresponding to the new pressure. As a result the hydraulic fluid breathes, as it were, alternately dissolving and releasing gas as hydraulic pressure increases and decreases. What effect did this have on operation of the aircraft's hydraulic system?

Figure 2. Change in Pressures in Aircraft Hydraulic System During Extension of Landing Gear in Flight. P_H, P_b, and P_{BX} are pressures in delivery lines, in supply tank, and at hydraulic pump inlet.

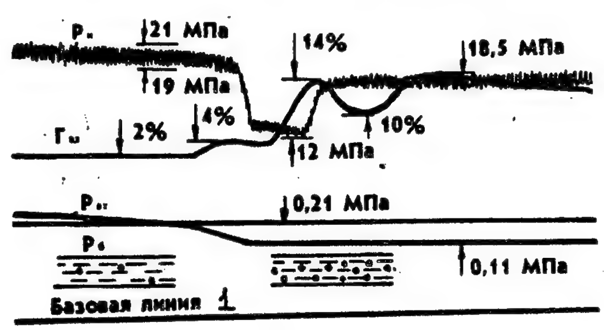


Key:
1. Base line

Assisted by the maintenance specialists, Lieutenant Ivanov determined that pressure in the delivery line and at the pump inlet dropped after switching the gear selector to the gear down position. But since hydraulic fluid passes to the pump inlet from the supply tank, in which it is saturated with gas, the following supposition was made: excess gas is released in the form of bubbles as a result of the pressure drop at the pump inlet. The flow of hydraulic fluid becomes two-phase, that is, it separates into gaseous and liquid components.

Figure 3 shows the nature of change in hydraulic system parameters when the pump shifts to increased flow. Apparently two-phase hydraulic fluid arrives at the pump inlet. The aviators concluded that a portion of the power stroke of the pistons in the pumps is expended on compressing air. As a result their efficiency drops. At high required loads, when the pump's automatic adjustment system is no longer capable of increasing flow (the

Figure 3. Nature of Change in Pressures in Hydraulic System and Gas Content of Flow of Hydraulic Fluid (G_{in}) at hydraulic pump inlet during transition to increased fluid feed. G_{in} is that part of the flow consisting of gas bubbles ($G_{in}=V_g/V_l$).



Key:
1. Base line

rocker assembly inclined disk is at the maximum output position), a pressure "collapse" occurs, which was noted by the pilots in the air.

The following must be noted. If hydraulic system pressure "dropoffs" are discussed in the operating and maintenance manuals, the manuals also indicate both flight phases and duration of pressure drop warning. When a warning is triggered during other flight phases, and when the warning is of considerable duration (more than 5-10 seconds), one must check to determine that the pump is in proper working order. Metal (most frequently bronze) chips trapped in filter elements in the hydraulic system circulation and delivery lines are an indicator of pump malfunction (beginning of failure). Air pockets in hydraulic lines, appearing after disassembly-assembly operations, can trigger a pressure drop warning. When this happens the hydraulic system must be thoroughly bled under pressure, as maintenance procedures prescribe. Failure to top off hydraulic fluid level can also cause a pressure drop in the hydraulic system due to the forming of a so-called "hole" in the supply tank outlet fitting when there is high pump flow.

Consequently, in each specific instance skilled and thorough examination of all circumstances which may cause a drop in an aircraft's hydraulic system pressure is essential. Both flight and, in particular, engineer-technician personnel of the operating units should possess the ability to perform such analysis, utilizing obtained data. This will make it possible to reach well-validated decisions and to recover from emergency situations with flying colors.

Calculating Mobile Target Status Probability

90R90001L Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 28-30

[Article, published under the heading "The Aviator and the Computer," by Military Pilot 1st Class Col A. Shilnov: "Hitting Mobile Targets"]

[Text] An article by Hero of the Soviet Union Col V. Pismennyy, which appeared in the 2 September 1989 issue of the newspaper KRASNAYA ZVEZDA, related how poorly organized coordination with ground troops and poor knowledge of combined-arms tactics led to mission failure by an element of helicopter gunships led by the squadron commander. The aircrews were tasked with hitting a motorized rifle battalion which, as the majority of battlefield targets, can be classified as mobile. The reason for the mission failure was failure to realize the importance of follow-up reconnaissance, one of the important conditions ensuring that one comes onto the target in an effective manner.

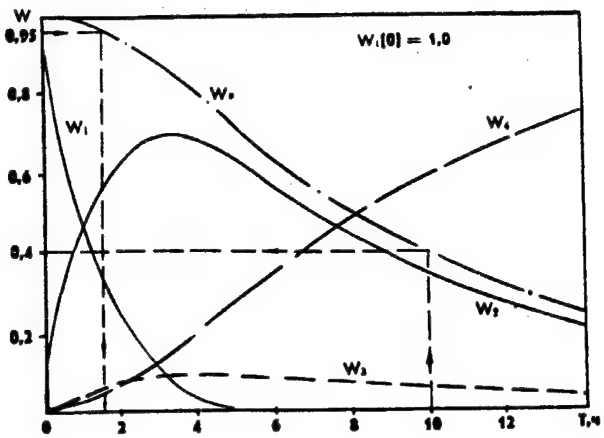
Four basic states or conditions are typical of mobile targets: razvertyvaniye [process of deployment or setup] (1), funktsionirovaniye [functioning or operation] (2), svertyvaniye [takedown or readying of installation for movement elsewhere] (3) and, finally, vykhod [departure, withdrawal] (4) from the deployment area. And the operational success of strike elements depends to a considerable degree on knowledge of the actual current state.

It would seem possible to determine the probabilities that a mobile target is in states 1-4 (W_1, W_2, W_3, W_4) and in a specified area (W_p) with the aid of the mathematical procedures of theory of Markovian processes. Graphs are plotted from the computation results, illustrating the relationships between these probabilities and the status of the target and time (T) which has passed from the moment of target detection to strike delivery (see diagram).

We should note that with such graphs one can also easily determine more accurately the maximum allowable time during which the probability that the target will be located in the specified area will be sufficiently high, that is, within a range of 0.9-0.95. If its actual value is greater, follow-up reconnaissance is simply essential.

In the incident described in the article, a force of helicopter gunships was to hit a motorized rifle battalion 10-12 hours after it was spotted. If the squadron commander had had such a graph at hand, he undoubtedly would have noted that the probability of finding the target in the specified area was very low (0.33-0.4). And he of course would have arranged for follow-up reconnaissance, which surely would have made it possible to avoid an unpleasant outcome.

The nature of relations $W_{1(2,3,4)}=f(T)$ is different for different mobile targets, and for this reason it is advisable to have graphs for each type. The graphs are plotted from data obtained with the following equations:



a) the target is spotted in the process of setting up or deploying, that is

$$W_1(0)=1{,}0;$$
$$W_1(T)=EXP(-T/T_{cp_1});$$
$$W_2(T)=T_{cp_2}[EXP(-T/T_{cp_1})-EXP(-T/T_{cp_2})]/(T_{cp_1}-T_{cp_2});$$
$$W_3(T)=\{T_{cp_1}T_{cp_3}[EXP(-T/T_{cp_1})-EXP(-T/T_{cp_3})]/(T_{cp_1}-T_{cp_3})-T_{cp_2}T_{cp_3}[EXP(-T/T_{cp_2})-EXP(-T/T_{cp_3})]/(T_{cp_2}-T_{cp_3})\}/(T_{cp_1}-T_{cp_2});$$
$$W_p(T)=W_1(T)+W_2(T)+W_3(T);$$
$$W_4(T)=1-W_p(T);$$

b) the target is spotted in the state of operation, that is $W_2(0)=1{,}0$;

$$W_1(T)=0;$$
$$W_2(T)=EXP(-T/T_{cp_2});$$
$$W_3(T)=T_{cp_3}[EXP(-T/T_{cp_2})-EXP(-T/T_{cp_3})]/(T_{cp_2}-T_{cp_3});$$
$$W_p(T)=W_2(T)+W_3(T);$$
$$W_4(T)=1-W_p(T);$$

c) the target is spotted in the process of taking down or readying for movement elsewhere, that is

$$W_3(0)=1{,}0;$$
$$W_1(T)=W_2(T)=0;$$
$$W_3(T)=EXP(-T/T_{cp_3});$$
$$W_p(T)=W_3(T);$$
$$W_4(T)=1-W_p(T),$$

where $T_{cp1(2,3)}$ is the average time during which the target is in state 1(2,3).

When $T_{cp1}=T_{cp2}=T_{cp3}$ determination of probabilities on the basis of the above equations leads to the appearance of uncertainty of type 0/0, which, however, is mathematically solvable. But in this instance it is simpler to change value T_{cpi} by quantity Delta$T_{cpi}=0.1T_{cpi}$, which has virtually no effect on accuracy of computation but makes it possible to eliminate uncertainty.

Plotting such graphs is a laborious process. Using a nonprogrammable pocket calculator to make the calculations, each requires up to 40-45 minutes. The following program, run on the Elektronika MK-52, -54, or -61 programmable pocket calculator, will help substantially reduce calculation time and help avoid errors. The curves illustrated above were computed and plotted in 12 minutes.

(12) ПРОГРАММА

00 П→x0	01 П→x1	02 ÷	03 /—/	04 Fe^x	05 x→П5
06 П→x0	07 П→x2	08 ÷	09 /—/	10 Fe^x	11 x→П6
12 П→x0	13 П→x3	14 ÷	15 /—/	16 Fe^x	17 x→П7
18 П→x1	19 П→x2	20 —	21 x→П8	22 П→x2	23 П→x3
24 —	25 x→П9	26 П→x1	27 П→x3	28 —	29 x→Пa
30 П→x4	31 1	32 —	33 Fx = o	34 69	35 П→x5
36 С/П	37 П→x5	38 П→x6	39 —	40 П→x2	41 ×
42 П→x8	43 ÷	44 С/П	45 П→x5	46 П→x7	47 —
48 П→xa	49 ÷	50 П→x3	51 ×	52 П→x1	53 ×
54 П→x6	55 П→x7	56 —	57 П→x9	58 ÷	59 П→x2
60 ×	61 П→x3	62 ×	63 —	64 П→x8	65 ÷
66 С/П	67 БП	68 00	69 П→x4	70 2	71 —
72 Fx = o	73 87	74 0	75 С/П	76 П→x6	77 С/П
78 П→x7	79 —	80 П→x3	81 ×	82 П→x9	83 ÷
84 С/П	85 БП	86 00	87 0	88 С/П	89 0
90 С/П	91 П→x7	92 С/П	93 БП	94 00	

(13) ИНСТРУКЦИЯ К ПРОГРАММЕ

(1) Нажать [F] [ВП.] (прг)

(2) Ввести программу.

(3) Перейти в режим вычислений: [F] [/—/] [В/О.] (АВТ)

(4) Ввести исходные данные:

T [x→П] [0] ;

$T_{ср_1}$ [x→П] [1;]

$T_{ср_2}$ [x→П] [2] ;

$T_{ср_3}$ [x→П] [3] ;

N [x→П] [4] .

(14) Примечание: N — номер состояния, в котором был обнаружен подвижный объект.

(15) ВНИМАНИЕ! Проверь соблюдение условий $T_{ср_1} \neq T_{ср_2} \neq T_{ср_3}$.

(5) Нажать С/П.

(6) Результат: W_1.

(7) Нажать С/П.

(8.) Результат: W_2.

(9) Нажать С/П.

(10) Результат: W_3.

(11.) Продолжение работы: перейти к п. 4.

(16) ПРИМЕР.

(17) Дано: T=2 ч, $T_{ср_1}$=1,5 ч, $T_{ср_2}$=8 ч, $T_{ср_3}$=1 ч, N=1÷3.

(18) Определить: W_1, W_2, W_3, W_p, W_4.

N=1; W_1=0,264; W_2=0,634; W_3=0,054; W_p=0,952; W_4=0,048.

N=2; W_1=0; W_2=0,779; W_3=0,092; W_p=0,871; W_4=0,129.

N=3; W_1=0; W_2=0; W_3=0,135; W_p=0,135; W_4=0,865.

(19) Время счета 25—30 с.

Continued on next page.

Key:
1. Press
2. Load program
3. Set to calculation mode
4. Enter data
5. Press
6. Result
7. Press
8. Result
9. Press
10. Result
11. Continue: go to step 4
12. Program
13. Program instructions
14. Note: N is the number of the state in which the mobile target was spotted.
15. Attention! Verify observance of conditions
16. Example.
17. Given
18. Determine
19. Calculation time

Analysis of Air Accident Risk Versus Cost Cost of Prevention

90R90001M Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 30-31

[Article, published under the heading "Following a Policy of Perestroyka," by Maj Gen Med Serv V. Ponomarenko, G. Stupakov, Lt Col Med Serv L. Drach, and Maj V. Karpov: "Risk—An Economic Category"]

[Text] **The concept of risk has been inadequately studied and developed up to the present time. Isolated, fragmentary studies are conducted involving calculation of reliability of certain machines, mechanisms, and systems in place of planned, systematic, comprehensive investigations. And yet this problem is extremely complex, even if one is dealing with the functioning of technical devices.**

It is particularly dangerous to underestimate the category of risk wherever systems of a differing nature adjoin one another, such as man-machine or social-technical systems.

The following article addresses the need for a qualitative breakthrough in this area—the formulation of a fundamentally new concept of risk, which should be combined with an ethically and economically well-reasoned relationship to technology and with the major organizational changes which are currently taking place in the Air Force.

* * *

Accomplishing the practical tasks of improving quality of flight operations and flight safety depends in large measure on a methodological approach to this problem. Since a leading role in the structure of causes of disruptions in flight operations is played by the human factor, this approach is connected first and foremost with analysis of the reliability of the work activities of the aviation specialist: pilot, navigator, engineer, and technician.

Reliability of flight activities contains a number of restrictions and limitations, which are determined by the mutual influence of many components of the "pilot-aircraft-environment" system. They are subdivided into internal components, pertaining to the person performing the activities, and external components, which characterize means, conditions, content, organization, and support of these activities.

In all cases reliability of the activities of the aviation specialist constitutes a derivative, which reflects the mutual influence of the entire aggregate of internal and external components. Since man's psychological capabilities are not limitless, and optimality of means is not achieved in all respects in modern aircraft, in most cases aviation personnel errors are to be expected. Basic components include excessive work load involved with performing the functions of receiving and processing information and decision-making in conditions where insufficient time is available. This is graphically apparent when comparing figures on frequency of erroneous actions in aircraft of different generations, which differ substantially in design regarding providing the pilot with information (Figure 1).

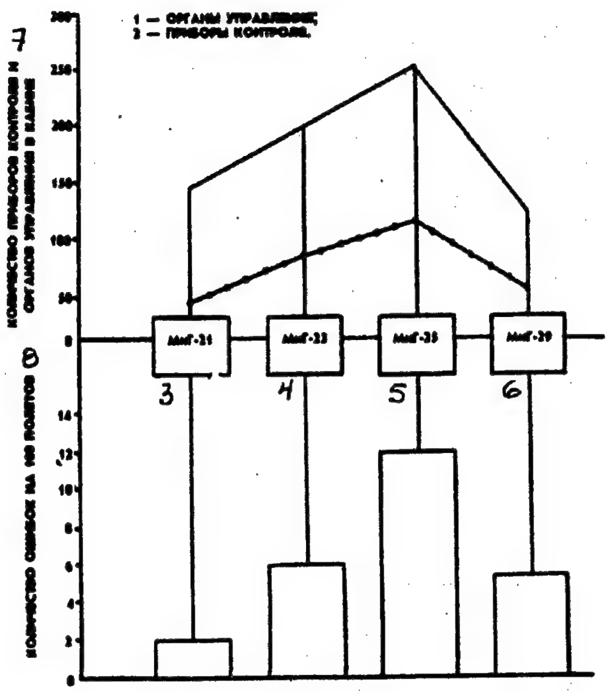
Errors are also caused by adverse external factors (noise, vibration, G-loads, etc), discomfort caused by work station, clothing, and special gear. Errors are also determined by the pilot's level of proficiency, his emotional, social, and physiological state. All these factors point to the groundlessness of an "ideology" of absolute flight safety and suggest substantiation of that maximum level of flight safety which will reflect the potentially attainable level of reliability.

The fact is that even with full optimization of internal (physical and emotional well-being of the operator) and external factors, including social, there always exists a certain risk of erroneous action as a result of dynamic restructuring of the active element (man) in the "pilot-aircraft-environment" system, with the possibility or, more precisely, even with the necessity of readjustment. This risk, which is determined by man's natural organization, is minimal in magnitude. In other words, it defines the upper level of reliability, toward which we strive.

Actual risk is always greater than determined risk, and the difference between them points to reserve potential and ways to optimize an aircraft system by increasing reliability of specialist and technician. This difference is nothing other than potentially removable risk of erroneous action, which can be accomplished by various methods, depending on selection of a level of reliability which is acceptable for practical purposes, as well as available means and resources.

The possibility of practical utilization of a faulty actions frequency indicator as a criterion of effectiveness of any

Figure 1. Relationship Between Frequency of Logical Erroneous Actions by Flight Personnel and Aircraft's Design Features.



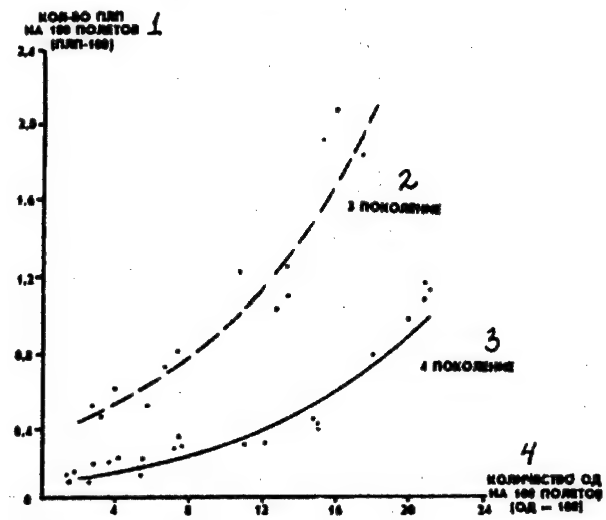
Key:
1. Controls
2. Gauges
3. MiG-21
4. MiG-23
5. MiG-25
6. MiG-29
7. Number of gauges and controls in cockpit
8. Number of errors per 100 flights

measures conducted in the interests of increasing reliability of an aircraft system can be confirmed by the results of a conducted analysis (Figure 2).

It is evident from the data that there exists a certain relationship between the number of mishap-threatening situations and the number of faulty actions. We should note that a similar correlation, with a specific numerical expression, also exists between the number of accident-threatening incidents and the number of air accidents. Consequently one can judge the probability of accident-threatening situations and air accidents from the indices on frequency of faulty actions as the most mass data gathered from flight operations. This relationship is highly specific and is determined by the type of aircraft and nature of missions being performed, which makes it possible to predict accident rate.

It is evident from the diagram that the interlinked indices differ on third-generation aircraft from the more

Figure 2. Interrelationship Between Indices of Frequency of Faulty Actions (FA) and Air Accident-Threatening Situations (ATS) on third-and fourth-generation aircraft.



Key:
1. Number of ATS per 100 flights (ATS-100)
2. Third generation
3. Fourth generation
4. Number of FA per 100 flights (FA=100)

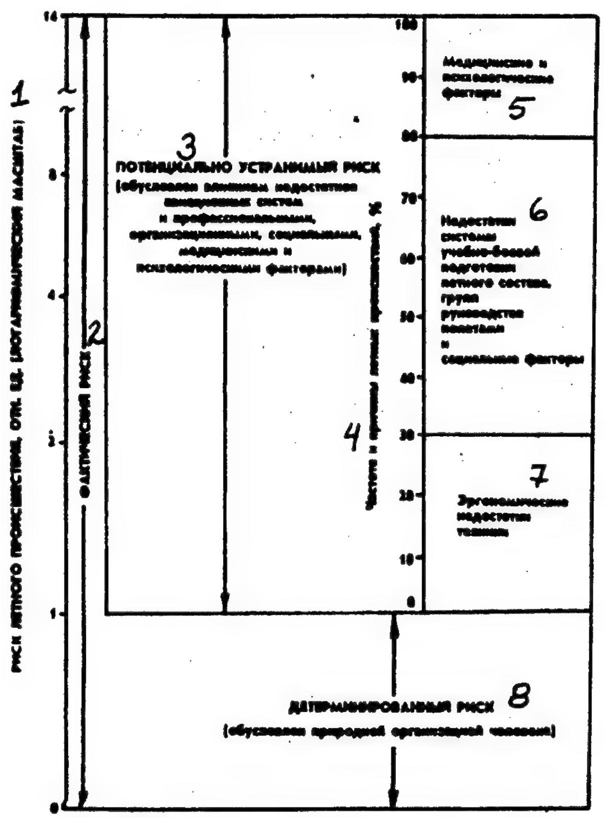
reliable fourth-generation aircraft. In this case the substantial difference clearly illustrates the effectiveness of the ergonomic considerations incorporated in new aircraft. At the same time, in order effectively to utilize this approach there is needed a substantial improvement in the system of determination and recording of faulty actions and mishap-threatening incidents as well as maximum computerization of these efforts within the framework of the proposed Air Force Safety automated information system (AVIATSIYA I KOSMONAVTIKA, No 11, 1989). Thus, synthesizing the presented points of a uniform methodological approach to solving the problem of improving flight operations effectiveness and flight safety, one can present the component of risk of air accidents in the form of a diagram (Figure 3). It reflects the current state of the problems of flight safety with presentation of the structure of causes of air accidents in the existing difference between actual and determined risk. As is apparent, risk of air accidents is 14 times the maximum achievable level of flight safety.

The concept of potentially removable risk attests to the possibility of reducing the number of air mishaps, but it does not of and by itself indicate specific organizational measures to achieve this goal. An appropriate "risk-benefit" analysis makes it possible to determine them, with benefit, in addition to decrease in pilot fatalities, also defined as including savings in equipment and resources. The overall result of such an analysis boils

Figure 3. Components of Risk of Air Accidents and Their Causes.

Key:

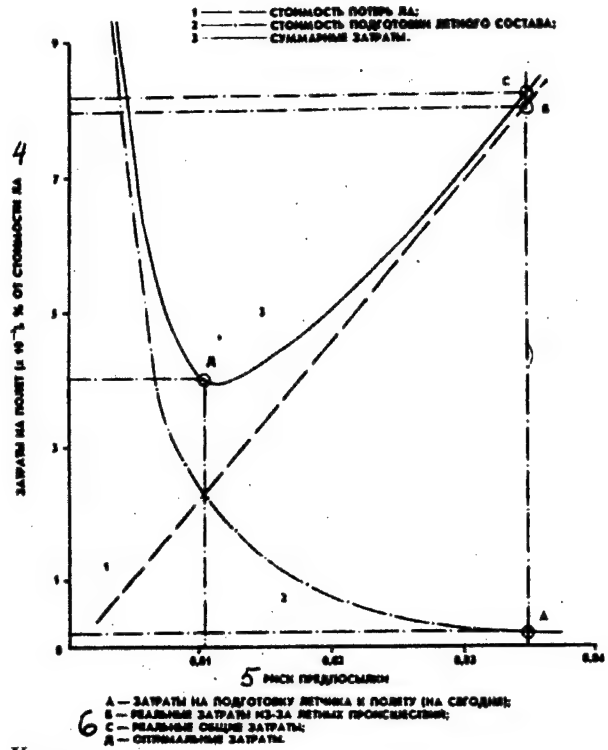
1. Risk of air mishap, relative units (logarithmic scale)
2. Actual risk
3. Potentially removable risk (determined by the effect of deficiencies in aircraft systems and professional, organizational, social, medical, and psychological factors)
4. Frequency and causes of air mishaps
5. Medical and psychological factors
6. Deficiencies in the system of training flight personnel and air traffic control personnel, and social factors
7. Ergonomic shortcomings of the equipment
8. Determined risk (due to natural organization of the human operator)



down to the conclusion that emphasis should be placed on material expenditures channeled into pilot training.

Figure 4 suggests that with current expenditures of training (point A) there is a high accident rate (point B), while the sum of these quantities determines overall expenditures (point C). With an increase in outlays on pilot training producing approximately a 0.01 risk of a mishap-threatening incident, the level of air accidents will decline severalfold, which as a result will ensure the most optimal outlays—below existing outlays by a factor of approximately 2 (point D).

Figure 4. Analysis of Risk-Expenditures Ratios.



Key:

1. Cost of aircraft losses
2. Cost of flight personnel training
3. Aggregate expenditures
4. Expenditures on flight (x 10^{-3}), percentage of aircraft cost
5. Risk of mishap-threatening incident
6. A—expenditures on pilot flight training (current); B—actual expenditures due to air accidents; C—actual overall expenditures; D—optimal expenditures.

The term "pilot training and preparation" encompasses a broad range of items: social (housing, jobs for family members, children's facilities at air bases); organizational (proper organization of the workday, work and rest regimen); effective simulator training, provision of sports facilities, rehabilitation centers, etc.

The following examples demonstrate the effectiveness of these measures: orderly arrangement of the work week, with two days off, leads to increasing the number of hours logged per mishap-threatening incident by 50 percent, while acquisition of functional rehabilitation complexes at the line-unit level results in an increase in total hours logged per accident-threatening incident by a factor of 1.6, while employment of an aggregate of rehabilitation measures in a specialized center environment makes it possible to ensure higher reliability of pilot activities over the course of four months.

By conservative estimates, effect generated by allocation of funds for the social, material, and intellectual needs of flight personnel can total the cost of several dozen aircraft per year.

Unquestionably practical implementation of specific measures to increase the operational reliability of aircraft systems requires utilizing not only a coordinated methodological approach and restructuring of the overall concept of preventing air mishaps, but also the conduct of a broad range of additional applied research.

At the same time, in summarizing results, one must once again mention the following important point. Erroneous or faulty actions, mishap-threatening incidents, and air accidents are inseparable phenomena of flight activity even under the condition of hypothetically absolute equipment reliability. The magnitude of their probability or risk is determined both by the natural organization of the human operator and by a great many external conditions, and contains the meaning of potential unreliability of human operator actions in a complex aircraft system. Consequently the term "pilot culpability" for a mistake or error (mishap-threatening incident, air accident) should not be used, since from a scientific standpoint it is incorrect, unethical from a societal standpoint, and harmful from a legal standpoint, due to the great many negative consequences to Air Force combat effectiveness.

Risk is an economic category, and degree of risk is a controllable quantity. The most correct and economically most advantageous way to go, in our opinion, is to increase the investment of funds and resources into the professional training system and to provide adequate social conditions and living conditions for Air Force personnel.

USAF Development Projects Pursue Military Superiority

90R90001N Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 34-35

[Article, published under the heading "Today's World and the New Thinking," by Lt Col V. Ovsyannikov, candidate of philosophical sciences: "A Look at the 21st Century"; based on materials in foreign publications]

[Text] Soviet peace initiatives, the Soviet-American dialogue on military issues, and talks on further nuclear and conventional arms reductions are supported by the broadest segments of the population in the countries of West and East. The 1989 signing of a Soviet-Finnish declaration offered new confirmation of humanitarian objectives in Soviet policy, as this declaration stresses that no use of force can be justified. Judging from the statements appearing in certain Soviet mass media, however, the seeming ease of reduction and even elimination of military potentials has caused in uninformed individuals a certain euphoria, an illusion that it is possible to guarantee our country's security without modern armed forces. One is particularly alarmed by the fact that recently, as noted by USSR Minister of Defense Army Gen D. T. Yazov at the September (1989) CPSU Central Committee Plenum, there have been open appeals to station Soviet military personnel in their own national regions, ultimatum-like demands to establish national military units and the performance of military service by persons of indigenous nationality exclusively on the territory of their own republic.

One frequently-encountered erroneous notion is that a change in foreign public opinion about our country is equated with a sharp shift in Western military policy. Unfortunately this is far from the truth. Recently U.S. Defense Secretary Richard Cheney stated: "The present is an entirely inappropriate time for the United States to alter that strategy which we have pursued with such success in recent years."

Many public figures with influence in government circles are highly skeptical about perestroyka in the Soviet Union. In particular, former U.S. secretary of state Henry Kissinger appeals "not to be seduced by the happy pictures drawn by the Soviet leader." Similar assessments and recommendations are shared by military Sovietologists who refuse to abandon their image of the "enemy." For example, people in the Otdel po Izucheniyu Sovetskoy Armii ["Department for Study of the Soviet Army"] view perestroyka in the USSR as a "breather," after which the Soviet Union, having strengthened its economy and upgraded its defense industries with new technologies, will once again return to offensive military thinking. At the same time awareness of the fact that a frontal ideological attack would hardly gain any popularity with world public opinion, direct accusations of "Red aggression" are replaced with an allegedly ideologically neutral postulate about the "unpredictability" and "illogical nature" of development of historical events.

As for predictions, it is apparent that indeed few members of U.S. military-political circles, for example, believed that our country would unilaterally embark upon a 500,000-man reduction in military manpower, or that the Soviet leaders plan to reduce by 1995 the percentage share of defense expenditures in national income by a factor of 1.5-2. And all this logically proceeds from the stated task of preventing war and the need for a radical decrease in the level of military confrontation, and bringing an end to the arms race.

Where is the logic in the thinking of the U.S. Department of Defense? Congressional and Pentagon documents on the military budget for Fiscal Year 1990-1991 and the military development program covering Fiscal Years 1990-1994 clearly attest to an endeavor to maintain military strength as the principal instrument of U.S. foreign policy. So that if there is some kind of logic in the far-reaching plans for modernizing U.S. military forces,

it is rather a military-technocratic logic, which is hardly in keeping with the new thinking.

Technocracy is embedded in the very foundation of the U.S. military-political strategy of "sopernichestvo" [competition; rivalry], devised in the mid-1980s. As we know, it consists essentially in escalating the arms race to a qualitatively higher level.

This policy assigns a particular role to aerospace weaponry. As is reported in AIR FORCE MAGAZINE, thousands of scientists and engineers working in 40 principal U.S. Air Force laboratories are redistributing manpower in order to take on a large number of projects, which guarantees them employment up to and beyond the year 2000. They claim that development trends of "revolutionary technologies" over the course of several years will bolster the obvious plans to produce new arms for the Air Force on a frightening [ustrashayushchiy—intimidating; deterrent] scale. The limits of these aspirations are evident to those who are acquainted with the "Scientific and Technological Development Program" devised by U.S. Air Force Systems Command specialists.

Their conceptual plan for the distant future, that is, into the 21st century, envisages robotic aircraft, automated strike systems, advanced missiles for gaining air superiority, self-operating antitank weapons, hypervelocity weapons, and long-lived high-altitude weapons platforms. Plans call for the development of laser communications systems, high-power microwave-energy weapons, stealthy transport aircraft, long-range conventional-warhead cruise missiles, and laser satellite communications systems.

The list of possible future military air systems for the 21st century contains more than 220 high-tech schemes in various areas. Each of them has a "main technological foundation," which contains a specific number of individual technologies. These include: photon technologies making it possible substantially to increase the capabilities of military computers and to lessen their vulnerability in an electronic warfare environment; high-temperature materials which retain their properties at 2200 degrees Celsius; nonlinear optical technologies which use light for automatic tracking and elimination of atmospheric interference; high-energy high-density fuels which make it possible substantially to increase fuel output while reducing fuel weight; systems utilizing artificial intelligence to perform human-like logic operations in flight and weapon control.

In the area of strategic offensive arms, U.S. Air Force officials hope to obtain weapons capable of rapid detection and strike delivery on strategic mobile targets (such as Soviet mobile ICBMs), as well as on deep-buried targets and command centers. In addition, they intend to lessen the vulnerability of bombers penetrating air defenses, and to increase the capabilities of tanker aircraft.

The plan to strengthen the missile portion of the nuclear triad includes the Peacekeeper rail-mobile, the mobile-launcher Midgetman, and the mobile Minuteman IV/V strategic missiles. Plans call for using new "burrowing" warheads to destroy underground bunkers.

Air Force development plans also devote considerable attention to development of a new generation of bomber-launched weapons, such as the SRAM II short-range air-to-ground missile and a future cruise missile designed to fool air defense radars. A number of key technologies developed in recent years constitute the basis for these systems. These include methods which make an aircraft less detectable, enriched chemical fuels, promising materials, multifunction sensors, automatic target tracking, multiple-source data processing, as well as methods which reduce the signature of nuclear devices reentering the atmosphere. Not one of these technologies has yet reached full development, although many are close to this stage, and in any case their utilization in the 21st century is entirely probable.

Counting on maximum effective exploitation of the technological advantage in the manned-bomber component of the strategic triad, Pentagon experts are endeavoring to develop "invisible" offensive air weapons employing Stealth technology. The AGM-129A Stealth nuclear cruise missile is scheduled to enter operational service at the beginning of the 1990s. Precision guidance, with appropriate modifications, will give it a range of 2300-2500 km carrying a conventional warhead.

In the opinion of foreign experts, the B-52 and B-1B bombers will be the principal cruise missile launch platforms up to the year 2000, joined by the B-2 Stealth bomber in the mid-1990s.

Initial appearance of the B-2 at the end of 1988 is one more indication of the fact that in the United States they have not given up a view of nuclear war as a means of achieving political objectives. U.S. Secretary of the Air Force Edward C. Aldridge, Jr stated that the B-2 allegedly "constitutes a stabilizing system in a time of crisis and is a most important component of our strategic forces." It is not difficult to grasp the point, however, that the development of a hard-to-detect aircraft with a combat radius of 8,000 km forces one to look for effective countermeasures in the military-technical domain. In addition, the hypothetical capability to deliver a surprise attack on enemy territory with impunity disrupts the military strategic balance and destabilizes the military-political situation.

As Northrop spokesman T. Jones noted, the B-2 is only the "first aircraft of the computer age." But it is not the last. According to the conceptual view of U.S. Air Force authorities, a variation of the X-30 hypersonic aerospace plane, which is supposed to fly at a speed of Mach 15 at an altitude of more than 90 km, may be a direct successor to the B-2.

U.S. tactical air forces are also being upgraded. The Lockheed Corporation developed the F-19A Stealth

fighter back at the beginning of the 1980s (some foreign publications designate this aircraft F-117A). One specific feature of this aircraft is the fact that not more than 5 percent of the aircraft's structure is of metal. According to reports in foreign publications, more than 50 aircraft of this type are currently in service with U.S. Air Force units.

Improving tactical air forces presumes development of the ATF Advanced Tactical Fighter. Requirements specified by U.S. Air Force Tactical Air Command specialists include capability to fight at night and in adverse weather, capability to detect and destroy mobile tactical targets, to fight and survive air-to-air combat. In addition to this program, a new aircraft is being developed for the close air support mission, the deep interdiction mission, and the defense suppression mission.

The Air Force Systems Command has at its disposal the world's largest aerospace facilities complex, located in the state of Tennessee and built at a cost of three billion dollars, for performing engineering calculations and ground-testing the new generation of aircraft. Experts believe that new computer-based analytical methods (the so-called "electronic wind tunnel"), together with ground and flight tests, will make it possible to develop aircraft with excellent preselected performance characteristics. The scale of the projects under development at this research center is indicated by the fact that it consumes annually approximately 500,000 megawatts of electricity—approximately as much as a city with a population of 50,000.

Air Force specialists are devoting considerable attention to the development of new command and control systems to be used in the war of the future, systems which reduce vulnerability of communications to electronic countermeasures, electromagnetic pulse, and physical effects; they include a missile, air and space attack tactical warning and evaluation system; these systems intensify such theater surveillance functions as target detection, tracking, and identification.

In the area of strategic command and control, the U.S. Air Force is seeking the capability to establish a global strategic warplanning system, a target data high-speed processing and correlation center, a planning system for the Strategic Air Command, and a mobile warning and combat information processing and display system.

Such large-scale utilization of the latest advances in science and technology for purposes of military preparations hardly fits within the framework of sufficiency for defensive purposes. It looks more like a long-range plan for gaining U.S. military superiority over the USSR, which runs roughshod over the hopes of mankind for a demilitarized 21st century. "Optimism is a fine thing. But there are many reasons which compel us to keep our powder dry," comments the author of an editorial in AIR FORCE MAGAZINE, with a meaningful nod in the direction of the USSR. What is the Soviet Union supposed to do in such a situation? I feel that sober reason is needed, not illusions, in order to understand this.

Developments in Aviation Abroad

90R90001O Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) p 39

[Briefs, published under the heading "Foreign Aviation Briefs"; based on materials in foreign publications]

[Text]

ATF Advanced Tactical Fighter Program

There is to be extensive application of Stealth technology (radar-scattering shapes, radar-absorbing materials, etc) in the new ATF combat aircraft, with Lockheed and Northrop each building two experimental prototypes. In the estimate of foreign experts, as a result of these measures, at certain forward-hemisphere aspect angles the aircraft's effective radar cross section will be less than 1 percent of that of the modern McDonnell Douglas F-15 fighter. It is believed that the effective range of a radar-guided weapon will decrease by a factor of 5-10 when used against the ATF fighter. For comparison we should note that the frontal radar cross section of the West European EFA combat aircraft which is presently under development will be approximately 20 percent of that of the conventional fighter.

In order to reduce the signature of the ATF fighter, which is to replace the Air Force's F-15 and the Navy's F-14, there is to be minimal engine operation on afterburners, the aircraft is to carry an advanced infrared target detection system and advanced electronic surveillance gear, plus employment of passive modes and provision of low probability of signal intercept when radar is operating in active modes. Radars being developed by Westinghouse and Texas Instruments for the Lockheed YF-22 and Northrop YF-23 respectively will feature active antenna arrays consisting of more than 2,000 small receiving-transmitting modules. Processing of radar signals, signals from the passive optoelectronic search sensors and ECM receiver unit will be performed with the aid of a common system of bus-linked processors, failure of any one of which will not result in failure of any sensor.

The U.S. Air Force has signed contracts with General Electric and Pratt & Whitney totaling 342 million dollars each for the development of engines for the experimental prototypes of the ATF. One of each pair of aircraft developed in the new program will be powered by two prototype Pratt & Whitney YF119 engines, while the other will be powered by the general electric YF120. Initial flight tests are to take place in 1990. One of the proposed airframes and one of the engines will be chosen for full-scale development in 1991.

The engines for the ATF are a result of the long-running U.S. Air Force/Navy JTDE program. The program is continuing, and recently General Electric was awarded two contracts.

One of these contracts (valued at more than 20 million dollars) is for building an improved-version primary duct for a fifth-generation turbofan developed in a U.S. Air Force program, and a gas generator for a future gas-turbine engine (Ategg). This primary duct was used in the General Electric engine developed in the JTDE program.

Testing of the fifth-generation engine primary duct was completed by General Electric in September 1987 and determined required design improvements in the second engine's hot section, testing of which is to be completed in September 1990.

The second contract, worth more than 34 million dollars, covers development of a new JTDE. The 18-million dollar initial development phase calls for development of an experimental engine and static testing of a high-performance fan. An additional 16 million dollars may be paid our for building and ground-testing a JTDE engine. Prototype engines are to develop a thrust of 15.9 t. Capability of deflecting thrust vector by + or -20° was demonstrated during testing of the XF120 flat-nozzle variable engine. Capability to deflect thrust vector across this range was also tested during testing of the XF119.

During debate on the ATF program by the House Appropriations Committee, concern was expressed that it might become the largest U.S. military program in the next decade, and that the actual cost of a single ATF aircraft could run approximately 90 million dollars, that is, would be considerably more than the price of 35 million dollars specified by the Air Force. According to the committee, the U.S. Defense Department has a "frivolous" attitude toward organization of joint Air Force-Navy ATF program activities. A committee spokesman stated that the U.S. Defense Department "authorized the Navy to study vaguely-defined versions of the future aircraft instead of directing efforts toward building an aircraft which would simultaneously meet Air Force and Navy requirements."

Experts estimate that the new technical improvements which will be used in developing the aircraft's avionics and software will be the most expensive components of the ATF. The budget request for Fiscal Year 1990 includes 1.1 billion dollars for development of the ATF for the Air Force and 65 million dollars for development of a carrier-based version. Due to unsatisfactory procurement schedules, the high degree of technical risk and the aircraft's cost, however, the committee voted down these appropriations. In the opinion of one of the committee members, a large part of the program is based on "unrealistic estimates." The date of entry into operational service had already been put back four years, and at the same time projected overall expenditures on research and development, aircraft testing and evaluation have increased by 900 million dollars and now total 13.5 billion.

For comparison we might note that the figured price of a fully-equipped West European EFA fighter is 25.5 million dollars.

Boeing for... Cruise Missiles

As we know, the U.S. Congress voted to cut appropriations for the low-signature Northrop B-2 strategic bomber. Discussed as one alternative was the possibility of developing Stealth-technology advanced long-range cruise missiles to be launched by existing widebody aircraft. It is noted that this idea was first put forward at the end of 1970, but it was rejected, in connection with which the Rockwell B-1B strategic bomber was developed. According to some reports the cost of modifying a Boeing 747-400 into a cruise missile launch platform, conditionally designated the B-3 by members of Congress, will total approximately 60 million dollars. This will require providing a system protecting against electromagnetic pulse and direct radiation from a nuclear burst, increased-thrust engines, and internal rotary launchers for cruise missiles. In view of capability to carry aboard a cruise missile launch platform a much larger number of missiles (up to 90) than on the B-2 bomber, the U.S. Air Force will need only 18 of these aircraft to destroy the same number of targets as can be destroyed by 132 B-2 bombers. The total cost of the cruise missile launch platform development program is estimated at 10 billion dollars, which corresponds to a 3.2 million dollar cost of delivering a warhead to the target, in comparison with 31 million dollars for the B-2 bomber.

Supporters of the B-2 bomber program claim that a cruise missile launch platform aircraft will not be able to perform combat missions with the same degree of flexibility as its predecessor. In addition, according to the SALT II Treaty, less stringent restrictions are placed on manned bombers than on cruise missiles.

Nippon Electric Corporation (NEC) has proposed a new radar-absorbent material which the company claims could find application in Stealth-technology aircraft. The material is a six-ply nonwoven fabric consisting of stainless steel and polyethylene fibers. NEC specialists believe that this material can absorb 99 percent of electromagnetic waves in the 4-14 GHz and 28-40 GHz bands. The material is to be used for suppressing antenna noise and reflections of TV signals from the walls of buildings.

Aircraft Maintenance Depot Economic Accountability Progress Report

90R90001P Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 40-41

[Article, published under the heading "Economic Reform in Action," by Col V. Mironov, head of Air Force aircraft maintenance depot: "The Main Job Lies Ahead"]

[Text] **Col V. Mironov, head of an Air Force aircraft maintenance depot, analyzes initial steps taken by the workforce toward mastering the second model of economic accountability**

Over the course of the last 15 years our facility has never failed to meet state plans and is considered an Air Force base enterprise for mastering forms and methods of economic activity and scientific organization of labor in the new conditions of economic management, as well as in training specialist personnel. We are also accomplishing other tasks in the interests of further improving organization and quality of major overhaul of aircraft and expanding manufacture of consumer goods.

It is apparent even from this brief statement that the workforce's decision to transition to the second model of economic accountability was grounded on a certain economic "backlog" and was prepared for psychologically. Nevertheless we were not counting on an immediate return on adoption of the new method of economic management, but that is the way things worked out. In the first six months of the year the enterprise, operating according to the second model of economic accountability, met its target in all economic indices, with 1989 targets specifying figures at least equal to those achieved with the first model. For example, the commodity output sales revenues plan fulfillment figure was 103.1 percent, while the economic-accountability income figure was 100.6 percent.

There are those to whom an increase of a few tenths of a percent is insignificant. And perhaps it is indeed not very impressive from a propagandist's point of view. But from the standpoint of the operations people and the economist, and considering that we, figuratively speaking, were unable to get a proper look at this second model, we see something highly desirable. Desirable primarily because it convinces people of the viability of the new conditions of economic management.

What basic principles guided our workforce in choosing the path of its future development? First of all it was improvement in internal economic accountability, converting all the enterprise's subdivisions over to a collective contract, "fitting" overall plant indices to those of the subdivisions, and a direct relationship between each employee's pay and the end results of the activities of the entire aircraft maintenance depot workforce. Secondly, we sought optimal possibilities for maximum expansion of democratic elements in production management and distribution of earned moneys. Thirdly, it was important correctly to accomplish the task of improving product quality by the influence of economic means on work performance results both of the plant as a whole and of its structural subdivisions.

We should note that genuine economic accountability is possible only under the condition that the internal economic management mechanism in all elements is linked with enterprise overall performance results. Just as self-financing will be meaningless if it does not eliminate unearned income.

I shall illustrate this with specific examples. Formation of payroll fund according to the first model of economic accountability, proceeding from a standard figure per ruble of commodity output, fails to reflect actual labor expenditure. Approximately the following principle is in operation here: the greater the quantity of component parts and materials used in aircraft overhaul, the greater the payroll fund will be. For example, based on work results covering the past six-month period, we could undeservedly receive an additional payroll fund amount of 201,800 rubles, which would amount to 9.3 percent of the total payroll fund.

Our second example is directly opposite to the first. The experience last year of brigades working on the basis of economic accountability demonstrated the impossibility of detailed calculation of savings in all types of materials and replacement parts. Figures on savings credited to individuals were for all intents and purposes not kept. As a result, with overall annual savings in material resources totaling 146,500 rubles, we were able to pay only... 700 rubles in reward bonuses to thrifty employees. This is one of the paradoxes engendered by an imperfect system of economic management: there is actual savings, and there is money, but we are unable to reward the deserving.

In conditions of the second model of economic accountability, payroll savings fund is formed according to the residual principle, after the enterprise settles accounts for material resources, meets its obligations to the state budget, the ministry, and the bank, forms production and social development funds, a financial reserve, and covers that part of wage deductions which (with the first model) is represented in uncompleted production and overhead expenditures.

We must state that we already learned from operations in the first quarter of this year that, in addition to payments for fixed productive assets, it is essential to schedule for the subdivisions payment for quota-determined working capital. We also calculated for the shops planned maximum allowable expenditures on materials and replacement parts in uncompleted production. Two shops, however, not bearing financial liability for this indicator, exceeded limits, which forced us to

take emergency measures at the plant level in order to meet the standard figure overall.

This incident convinced us of the need to maintain strict oversight over material outlays invested in uncompleted production and unsold commodity output, since even with good figures for commodity output and profit (according to the first model), it is possible not to reach the targeted income figure and, consequently, the targeted payroll fund figure as well.

The residual-principle variation of payroll funding focuses the entire workforce on economical expenditure of labor and material resources, thrifty equipment operation, and encourages maintaining the minimum essential fixed productive assets and working capital.

In preparing to operate according to the second model of economic accountability, in 1988 we reduced fixed productive assets by 276,700 rubles and increased commodity output volume by 107.2 percent, with unchanged working capital allowance. In spite of the fact that there was a change in the procedure of calculating the standard ratio of labor productivity (income) growth and payroll fund (labor remuneration fund), the enterprise, having stabilized payroll in the service subdivisions, was able to provide greater incentive to achieve savings in material resources in the shops. We now pay out for savings up to 50 percent of the value of economized materials.

Payroll unutilized in the subdivisions is kept by them as a reserve fund to the end of the year and can be utilized in the shops within standard ratio limits, and in the departments within the limits of annual estimated total expenditures or, in the fourth quarter, within the limits of untaxed payroll fund. Internal management calculation procedures are constantly being adjusted at the enterprise. For example, we introduced a payment for exceeding material expenditures in uncompleted production and correspondingly began targeting for the shop a total in materials and replacement parts in uncompleted production. Operating experience indicated, however, that this too was insufficient, for with a change in the product list, payroll fund changes with a difference in materials intensiveness, with the same revenues and plan fulfillment in all indices. Then it may happen that some subdivision undeservedly receives additional payroll or, on the contrary, fails to receive earned payroll. I feel that conditions of targeting should be altered, that is, evidently material expenditures should be targeted for gross output.

As already stated above, the problem of expanding democratic elements in enterprise management and in management of enterprise structural subdivisions, and distribution of earned funds by the workforces themselves is no less important with the second model of economic accountability. Except for the technical inspection department, kindergarten, services and utilities, hotel, scientific and technical information office and industrial safety office, all subdivisions entered into a contract with management pertaining to working under a collective contract. Including management subdivisions. They autonomously draw up provisions on manner and procedure of disbursement of payroll, applying labor contribution and labor participation factors.

Typically workforces utilize the labor participation factor fairly frequently. The labor participation factor was changed in 1,603 instances, for example, for the period covering the first two quarters of 1989, which attests to the fact that people are not indifferent toward one another's work effort in the brigades and departments. Behind this positive trend, however, one can see a psychological unpreparedness on the part of many employees for independent utilization of economic incentives and penalties. There is still a great fear of "offending" one's comrade, even if he deserves it.

The department workforces receive payroll on the basis of targeted work estimates. In case of failure to meet targets for the month, quarter, or year, the expenditures amount based on the estimate, which includes salaries of specialist personnel and incentive fund (former material incentive fund), is not paid in its entirety. In the first six months of the year we had such cases in the design department and in the automated planning and management systems department. The specialist personnel of these subdivisions lost significantly in wages.

The collective contract makes it possible to speed up adoption of principles of plant internal economic accountability in each production section, ensures a direct link between labor remuneration, incentive, and the end results of our work performance, and makes it possible actively to involve all aircraft overhaul personnel in the process of management, in the search for and effective utilization of production reserve potential.

Before this year there never arose among the workers such questions as, for example, why it is that funds are contributed precisely from the shop, according to a certain standard figure, into common plant funds; why it is that people are taken from the brigades to train foreign specialist personnel, and yet the section is not compensated for the losses; how do fixed assets affect wages; plus others.

We have become convinced that, in spite of aggressive teaching in the new methods of economic accountability, people have trouble assimilating the points of theory. As a rule, at the present time only extreme situations arising in the subdivisions provide an opportunity clearly to unite theory with practice. I shall state quite frankly that our basic problem at the present time is the fact of economic illiteracy on the part of many employees. In conditions of the second model of economic accountability, we are hoping to eliminate this gap by the end of the five-year period.

The enterprise collective contract resumes utilization of the second model of internal economic accountability. Enterprise operations on these principles link well with a collective contract involving all structural subdivisions,

including the edifice of management. Management and service element activity on the contract pertaining to ratified estimates guarantees performance of work included in the estimates, but it reduces speed and flexibility of solving problems which arise in the process of production. The reason for this lies in the impossibility of paying for additional work with the existence, restricting our autonomy, of a standard correlation between labor productivity and wage growth or 3-percent growth in payroll from the fourth quarter. Although calculations have shown that payroll at the enterprise will not be exceeded by more than 3 percent with the targeted average earnings growth and that problems will not arise in the workforce. The residual principle of payroll funding with rate setting in good condition has prevented unwarrantedly rapid wage growth. The enterprise has amassed sufficient payroll reserves to finance additional work not specified in the plan.

A third important indicator of economic-accountability relations is the direct dependence of each worker's pay on quality of product turned out, since all costs connected with the production of poor-quality goods are fully debited to the economic activities of the subdivisions and to workforce payroll. The role of autonomous internal shop inspection and oversight increases thereby. In the past only those responsible for defective goods had their wage bonuses reduced, while now the entire workforce bears financial liability, since poor work leads to a decrease in the overall payroll fund.

In the last six-month period our enterprise had a high product quality figure. The period did not go by entirely without customer complaint, however. The cost of making good was taken from the payroll fund, in an amount of 1,092 rubles.

The number of deviation cards, which record plant internal rejects, has decreased from 217 in 1988 to 134 in 1989, and wage losses for those employees responsible totaled 808 rubles last year and 427 rubles this year. The labor contract workforces, however, having accumulated a payroll reserve by limiting payouts (based on a standard ratio of wage growth to labor productivity), have begun responding more gracefully to customer complaints, knowing that they can cover losses with the reserve and that economic penalties will have virtually no effect on employee wages. There has also been a decrease in the effectiveness of economic-accountability claims made by subdivisions on one another for sustained loss. In our opinion only replacement of the standard ratio with a progressive tax on payroll can significantly increase the effectiveness of internal economic accountability grounded on the second model.

Another bad point is the fact that at the present time economic instruments are not operating within the domain of interrelations between the enterprise and those who use our product. In 34 out of 37 cases where depot specialist personnel were summoned to air units, claims against the maintenance depot were not filed. Does this match reality? Unfortunately some unit commanders give in to our representatives' entreaties to change in the report documents the statement as to the actual cause of an aircraft malfunction. This happens because the military unit does not bear financial liability for unwarranted summoning of specialists, and every commander and superior officer has a stake in maintaining good relations with the maintenance depot people.

Such "pity" for those responsible for defective goods is also sometimes manifested on the part of certain enterprise quality control people. This is one of the reasons for the substantial decrease in the number of rejection cards.

The demand of accountability to the higher command authority for the first and second models of economic accountability simultaneously serves as a powerful inhibiting factor against expanding enterprise autonomy. These accountability reports are incompatible, especially in indices pertaining to wages, material incentive fund, and wage bonuses from payroll funds and labor remuneration fund. It is therefore essential to revise the system of accountability and to bring it into conformity with the new conditions of economic management, especially in matters pertaining to labor and wages.

We believe that further improvement of depot internal economic accountability and enterprise operations following the second model will make it possible in the near future more effectively to utilize the enterprise's economic capabilities both in the interests of development of the Air Force and of our entire economy.

West European Nation Space Programs Reviewed

90R90001Q Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 42-43

[Article, published under the heading "Readers Request," by A. Kislyakov: "Space Program in the Countries of Western Europe"; based on materials in foreign publications; part one of two-part article]

[Text] **For quite some time now Western Europe has been actively participating in space exploration and utilization. Development of satellite communications systems, utilization of scientific satellites and earth resources satellites, and projects in the area of manned space flight offer vivid confirmation of this. The space program has been developing at a particularly rapid pace in recent years, due to the enormous possibilities it is opening up for the economy.**

With this article we are continuing, at the request of our readers, the series of articles on the space program abroad which was begun in 1988 and 1989.

France. Activities in the field of space exploration and utilization are directed by the National Center for Space Exploration (CNES). Established in 1962 with headquarters in Paris, it currently employs approximately 2,290 persons and boasts a budget of 7.7 billion francs (1.2 billion dollars as of 1989). It operates three centers and the Kourou space launch facility (in French Guiana). A rocket booster design office is located in Evry, near Paris, while the Satellite Tracking Center and Hermes project center are located in Toulouse. The state enterprises Aerospatiale and SEP are the principal enterprises specializing in space-related contracts. Privately-owned companies also have a large share of these activities, the largest of which are Matra and Thompson. The former develops satellites and satellite-borne equipment, while the latter develops electronic equipment.

France was the world's sixth country (following the USSR, the United States, Great Britain, Canada, and Italy) to place a satellite in orbit, in 1965, which was boosted into orbit by a French-built launch vehicle.

The French space program has devoted and continues to devote principal attention to the development of communications and earth resources satellites, such as Telecom, TDF, and SPOT. France is the only West European country to develop its own national satellite communications system. This system uses three satellites: Telecom-1A, Telecom-1B, and Telecom-1C, which were lifted into geosynchronous orbit by the Ariane booster.

The launch weight of a Telecom-1 satellite is 1,170 kg, with a mass in geosynchronous orbit (after the solid-fuel final orbital-insertion motor has expended its fuel) is 650 kg. The satellite measures 3 meters in height and 2.2 meters in diameter. The satellites each carry 12 S-band repeaters and provide radiotelephone communications and transmission of color TV programming. They are also used as part of a military communications system; this will be discussed below. Satellites of this model are designed for an operating life of seven years.

Work is also in progress on development of improved Telecom-2 satellites to be used both in civil and in military telecommunications systems. The first of three Telecom-2 satellites is to be boosted into orbit in 1990.

The Eurosatellite consortium, which includes both French and West German companies, develops direct TV broadcast satellites. Satellites for France are called TDF, while those for the FRG are called TV-SAT. The first TDF satellite was launched by an Ariane 2 booster from the Kourou launch facility in October 1988.

TDF-1 transmits high-quality picture and sound color TV programming, including digital stereo sound. In spite of what would seem to be an obvious benefit, however, the French did not respond very enthusiastically to the first satellite, as a result of which the question of its profitability was raised at the beginning of 1989. Only two of the satellite's five channels have been leased out to date: one channel is the new French Channel 7, La Sept, while the other channel carries the West German Bundespot.

The second factor militating against this satellite's "popularity" was the fact that it uses a new TV broadcasting standard known by the name D-2-Mac Packet. The fact is that this standard was adopted at a conference in Dubrovnik in May 1986 as the future uniform TV broadcasting standard for Western Europe. But at the present time French television uses the SECAM standard, while most European countries use the PAL system; the United States and Japan have adopted the NTSC standard. Unquestionably this creates difficulties both for the public and the television equipment industry.

Now a few words about the SPOT satellite (SPOT is an acronym for Experimental System for Observing the Earth). These satellites are comparable to communications satellites in their commercial significance. It is therefore legitimate to call the French SPOT program (we shall consider it a purely French program, in spite of the fact that Belgium and Sweden are also participating in it) the most successful of all national projects.

Development of the first satellite in the SPOT family—SPOT-1, designed as an earth resources satellite—began in 1978. In February 1986 this satellite, weighing 1,809 kg, was launched into an 830 kilometer high orbit. Its tubular frame and panels for mounting equipment are of an aluminum alloy and carbon fiber. The satellite can provide real-time transmission of telemetry and other data or can record data for later transmission. The satellite carries two radiometer telescopes with a 10-20 meter resolution in various regions of the spectrum.

In spite of the fact that the designed service life of the SPOT-1 satellite is two years, this satellite is continuing to operate. In the spring of 1988 the French Spot-Image consortium, which engages in the commercial distribution of images obtained by this satellite, made public some of the statistics of its two-year operation. A total of 625,000 images have been obtained during this period. They are being used by 109 different countries, including the United States.

According to CNES plans, the SPOT-2 and SPOT-3 satellites are to be launched from the Kourou space launch facility at the end of 1989 and after 1990 respectively. Recently the French Government made the decision to begin development of improved SPOT-4 and SPOT-5 satellites.

Of the international programs in which France is taking part, I would like specifically to mention the KOSPAS-SARSAT program. The most active role in this program is being played by the USSR and the United States, whose satellites carry appropriate communications relay equipment. France has set up a SARSAT system center

in Toulouse, and is also to be supplying for U.S. satellites, jointly with Canada, satellite-borne systems to relay signals and determine the coordinates of ships and aircraft in distress.

Speaking of bilateral French dealings in space activities, we should stress that, in spite of active participation in various ESA projects and a fairly robust national program, this country nevertheless is in acute need of collaboration with the leading "space" powers. French-Soviet cooperation in the space exploration field has always developed in a stable manner. Back in 1977 a Soviet rocket boosted the French scientific satellite Sneg-3 into orbit. This was followed by the Vega project and the stay aboard the Mir space station by French cosmonaut Jean-Loup Chretien. All these events were covered by the mass media in our country, and for this reason I believe we should discuss in somewhat greater detail collaboration between France and the United States and, in particular, mention two programs.

The first is called Argos and involves providing U.S. NOAA weather satellites with instrumentation giving capability to relay information from unmanned ground stations as well as from marine buoys, atmospheric sounding balloons, and even from miniature transmitters attached to the bodies of birds and animals, particularly whales and dolphins, in order to study their migration. Data on temperature, pressure, wind velocity, etc are obtained from unmanned sites.

The second and most significant of bilateral space projects involves the participation in June 1985 of French mission specialist Patrick Beaudrie in a seven-day U.S. space shuttle mission. He performed a number of scientific experiments aboard the shuttle Discovery, for the most part involving study of heart activity and blood circulation in weightlessness, using an echograph. These experiments produced information on the initial phase of the system's adaptation to weightlessness. Shuttle missions are of limited duration, however, while such experiments require extended observations, and for this reason CNES requested that the USSR provide the opportunity to conduct similar experiments aboard the Mir space station, but over a longer period of time. The work begun by P. Beaudrie was successfully completed by Jean-Loup Chretien on the Soviet space station.

In addition to peaceful uses of space technology, there has recently been noted in France a tendency toward its utilization for Ministry of Defense purposes.

Seeking total independence from the United States in the area of arms, France is endeavoring, according to materials appearing in foreign publications, to acquire its own military space arsenal, like those facilities which are either already in service or are planned for future entry into U.S. operational service. The French seek to develop a ballistic missile early warning satellite.

But let us talk about the system which has already entered operational service, after which we shall examine a military satellite system of the not too distant future, according to the plans of France's Ministry of Defense.

We have noted that at the present time France is the only West European country to establish a civil satellite telecommunications system, based on the Telecom-1 satellite. Using these satellites, the Ministry of Defense has developed and is successfully operating a military satellite telecommunications system, called Syracuse-1.

The Syracuse-1 system became operational in 1985 and has been in continuous development since that time. Intended to be used for rapid, secure command and control of all branches of service, at the present time the system includes 26 fixed-site ground receiving and transmitting stations, as well as a large number of mobile stations on ground vehicles, ships, and aircraft. We should also note the first combat use of the Syracuse-1 system. It took place on 20 February 1986, when the expeditionary corps in Chad set up a ground station at N'djamena airport to handle command and control of French ground forces.

In the summer of 1988 the Ministry of Defense decided to establish the Syracuse-2 Military Satellite Telecommunications System, based on the Telecom-2 satellite. Direct supervision of the Syracuse-2 project was assigned to the electronics and computers section of the General Delegation on Arms. The total cost of the project is estimated at approximately 7 billion francs. After the Syracuse-2 system becomes operational, the total number of fixed-site and mobile ground stations will reach 100-120.

Based on statements made by French Defense Ministry official spokesmen, Western observers report that the first satellite of the Helios family, a TV imaging and electronic reconnaissance satellite, is to be launched into orbit in July 1993. One of the primary missions of this satellite is to obtain reliable data on the characteristics of the potential adversary's air defense radars. Italy and Spain have decided to participate in the Helios program. Italy has assumed 14 percent and Spain 5 percent of satellite development costs. Total spending on the program is estimated at 7.6 billion francs.

The satellite's launch weight is 2.5 tons. It is based on improved SPOT satellites and is equipped with an optical telescope with electronic scanning sensors, with a resolution of 1 meter (orbital altitude 850 kg). The first Helios satellite is to be lifted into orbit by an Ariane 4 booster. **(To be concluded)**

Cosmonaut Pre-Mission Training Described

90R90001R Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 44-45

[Article, published under the heading "Cosmonaut Training," by twice Hero of the Soviet Union Maj Gen

Avn V. Dzhanibekov, Pilot-Cosmonaut USSR, and Col V. Dmitrov: "Problems-Approach Training Methods"]

[Text] Cosmonaut training is an unconventional concept which stands apart from similar concepts applying to other domains of human activity. While a pilot, truck driver, or radar operator is trained on actual equipment and facilities under the direct supervision of instructors, the cosmonaut operates under worse conditions in comparison. He is sent into space directly from the simulator, without an instructor who could help him along and correct his errors, and who could make a decision if unforeseen emergency situations arose.

As practical experience has shown, the most complex and critical phase of cosmonaut training is the phase of direct crew training on the integrated simulators for the Soyuz-TM spacecraft and the Mir orbital space station with the Kvant, D, and T modules, which comprises almost half of the total program.

The main purpose of training on integrated simulators is to reach a level of crew readiness guaranteeing accomplishment of the mission program. In the course of training the instructor considers the level of the trainees' knowledge and skills and gives them performance marks each time they come together, which provides the cosmonauts with incentive toward more aggressive mastery of the training program. It is important not only to develop in the cosmonaut the requisite skills in working with the various systems and equipment, but also to develop heuristic thinking in the cosmonaut, based on problems-approach training methods, that is, the ability to determine the shortest optimal paths toward accomplishing mission objectives in the most unexpected, unforeseen situations.

Training crew members on the integrated simulators is preceded by a program of classes in theory as well as practical class sessions. In lecture classes they study the design and construction of a specific piece of space hardware, its systems and equipment, gain an understanding of quantitative and qualitative evaluation of systems operation, and systems control procedures in case of determined emergency situations. This is followed by a series of practical training classes on the simulators, stand-mounted training devices, and in the laboratory. Only after this do the cosmonauts proceed with training sessions on the combined or integral simulators.

The training schedule on the integral simulators contains two phases. The principal goal of the first phase is to develop in the crew members the required (specified) work style as an aggregate of mandatory procedures, standards and skills, which are to be acquired on the simulators. Work style is determined by quantitative, qualitative, or expert evaluations of mission task performance.

Qualitative criteria at the first stage of training include proper sequence, consistency, promptness, accuracy, and correctness of commands when working with onboard documentation; completeness of monitoring, verification, promptness and correctness of assessment of the status of spacecraft and space station systems; promptness and efficiency, precision, adequacy, specificity, and adherence to the specified terminology in conducting communications with mission control; promptness in detecting malfunctions, optimality of actions, correctness, promptness and efficiency in responding to an emergency situation.

Quantitative criteria include, for example, when performing manual initial docking contact and hard docking procedures: time, fuel consumption, and precision of docking assembly entry.

Skills during cosmonaut training are achieved by regular practice drills. Each consists of a crew procedures checklist, with procedures identical in structure to those performed during an actual space mission. During training the crew should view the simulator as an actual spacecraft and the practice session as an actual space flight. All emergency situations cranked in by the instructor, as well as possible simulator malfunctions, are to be perceived by the crew as system malfunctions during an actual mission.

At the beginning of training, while not imposing harsh demands on precision of performance, it is important to seek to ensure correctness of crew performance of a given operation from the moment when the crew has thoroughly assimilated the procedure and sequence of required actions in each specific situation. Some schematization and simplification of training drill conditions are even useful at the beginning of the first phase of training, especially for crews lacking actual manned mission experience. Subsequently the required accuracy and precision are honed and complexity of the practice drills is increased.

In order to automate the training process and to adjust it in a prompt, flexible manner, instructors make a record of crew member faulty actions during each practice session on the integral simulator. Current experience has made it possible to subdivide them into groups on the basis of the consequences to which they lead. Each error has its own weighted factor, determined by the method of expert analysis. We shall cite as an example six groups of evaluated actions.

1. Crew actions causing (simulated during ground training) the "death" of crew members. For example, collision between spacecraft and space station during the performance of manual initial docking contact and hard docking; incorrect actions leading to spacecraft total depressurization, etc.

2. Crew actions leading to scrubbing the mission and premature descent from orbit. For example, failure to accomplish spacecraft docking with the space station.

3. Crew actions leading to scrubbing a dynamic sequence, postponing it to the following revolution or

day. For example, failure of orbital correction maneuver or maneuver to turn toward the sun in order to charge solar panels.

4. Crew actions leading to failure to accomplish an operation, experiment, or specific task.

5. Crew actions leading to failure to stay within standard limits of particular criteria, but not leading to failure to accomplish the mission program, that is, actions which are corrected in a prompt and timely manner. For example, failure to adhere to proper sequence of commands, incorrect issuing of commands or at the wrong time, lack of specified monitoring or verification, etc.

6. Nonoptimal actions, also failing to affect performance of procedures, operation, and mission program.

Utilizing number and distribution of faulty actions (with corresponding weighting factors), the instructor determines the pattern of development of crew skills, which makes it possible to determine not only the general training trend but also specific features of the process: occurrence of drop in intensity of cognitive activity, cessation of skill improvement, appearance of signs of fatigue or overtraining, etc. In addition it is possible to find a relationship between practice session result quantitative characteristics measurement trends and intervals between training sessions.

Upon completing the first-phase training program and on successfully completing the performance-graded final practice drill, the crew proceeds to the second phase of training.

The purpose of the second phase of crew training on the integrated simulators is to develop orbital flight skills in crew members, that is, the ability to utilize their acquired knowledge and skills in a purposeful and innovative manner and the ability to find the shortest path to accomplishment of flight program tasks in the most unforeseen situations. Particular attention is devoted to this phase of cosmonaut training, since for successful performance in orbit it is not enough to possess only the sure skills in working with spacecraft systems and equipment acquired during the first phase. Even after running through and rehearsing on the ground all abnormal and emergency situations covered in the onboard documentation, that is, accomplishing the tasks of the first phase of training, the crew is not guaranteed against the occurrence of unforeseen emergency situations during flight.

As a rule practical manned-mission experience confirms this assumption. This is why the complex but effective problems-approach training method is applied in the second phase of training, a method aimed at mobilizing, forming and shaping the trainees' cognitive abilities by involving them in independent participation in analyzing situations which have not previously been formed and which cause difficulties. The aggregate of such purposefully-designed theoretical and practical problem tasks presented to the crew and distributed following the principle of increasing degree of complexity, constitutes the second-phase training program.

Practical experience engenders three different problems-approach training methods. The first method consists essentially in the following: having created a problem situation, the instructor not only provides the end solution to the problem but also reveals the logic of movement toward this solution in its contradictions, conflicts, and deviations, and shows their sources, reasoning through each step. This type of presentation, which can be used both with theoretical material and in practical work on the simulators, evokes in the cosmonauts an involuntary need to follow the logic of presentation, to verify the correctness of each step, and to bring forth questions, doubts, and objections. This forms the ability to see the problem, critical thinking, and the ability to consider and find alternatives.

The strength of problem presentation lies in its predictive qualities. As he listens to the well-constructed presentation or works on the problem in a practical manner, the cosmonaut frequently anticipates the next step or constructs it differently, in his own way, thus manifesting an optimal form of innovativeness at a given level. Having perceived the scheme of presentation, the cosmonaut is capable of carrying this pattern over to other situations.

The second problems-approach training method is in part a searching or heuristic method, whereby the cosmonaut solves a problem and performs a task with various assistance from the instructor, who can provide prompting for the first or succeeding step which is impeding solution, while the cosmonaut himself prescribes all the other steps. The instructor may construct a problem solution plan, while plan implementation is done by the cosmonaut. If the crew is unable to solve a problem, the instructor constructs another, similar problem, but with a narrowed field of search. In another instance the instructor subdivides a difficult problem into two or three subproblems, each of which is easier, but which together provide the solution to the main problem. In a third variation the instructor provides additional data on a condition of a difficult problem, limiting the number of solution steps and narrowing the field of search.

This method does not ensure crew preparedness to solve integral problems, since such solution requires independent passage through all phases of problem solution. But since an integral process of solving any problem requires certain investigation, the third problems approach training method corresponds to it.

It consists essentially in the following: the instructor formulates problems and problem tasks in a certain system, in the form of research or study problems, while the cosmonauts perform the tasks entirely on their own, thus carrying out creative inquiry. The instructor, in presenting a given problem for independent handling, knows the solution, the procedure of solution, and those

features of innovative activity which must be manifested in the course of solving the problem. Thus constructing a system of such problems makes it possible to program crew activities which gradually lead to forming of the requisite traits of innovative thought process which is the objective of the second phase of cosmonaut training on integrated simulators.

In the actual training process all three methods are frequently combined, whereby the first two methods can be applied in the first phase of cosmonaut training, while the third method can be used more extensively in the second phase and the phase of maintaining knowledge, skills, and abilities.

After successful completion of the two phases of training, the crew undertakes a combined performance-graded practice drill, conducted approximately one month prior to launch.

The performance-graded training drill runs continuously for a period of 10 to 12 hours, covering almost all spacecraft mission operating modes: boost into orbit, systems checks, orbital correction maneuvers, approach to and docking with the space station (sometimes done separately), undocking and descent from orbit. Before the drill session begins, the crew is given examination cards, containing the session scenario: abnormal situations which crews will need to detect, identify, and take appropriate corrective measures for continuing the mission and ensuring flight safety.

Following completion of the combined performance-graded drill session and subsequent performance critique and analysis by specialist personnel, the crew is given a performance grade. The grade is given in conformity with the prescribed method, using a four-point system.

If the crew receives marks of 5 and 4, approval is given for it to fly the mission.

If the crew receives a mark of satisfactory, in contrast to college-level schooling, where this is a passing grade, the crew is given an additional training program in an amount determined by the approval board, for the purpose of correcting performance deficiencies. After completing the additional training program, the crew goes through another combined performance-graded training drill.

If a crew receives a mark of unsatisfactory, it is not approved to fly the mission.

On the whole practical space mission experience has shown the correctness of the methods principles of training cosmonauts on integrated simulators as used at the Cosmonaut Training Center imeni Yu. A. Gagarin. The volume and content of training ensures completion of mission programs both in normal and abnormal or emergency situations.

Airfield Technical Support Battalion Performs Efficiently

90R90001S Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 90 (signed to press 7 Dec 89) pp 46-47

[Article, published under the heading "They Support Flight Operations," by Capt A. Obukhov, aviation technical unit electrical and gas equipment engineer: "Precise Rhythm of the Airfield"]

[Text] Prior to commencement of night flight operations, the senior check pilot asked Lt Col V. Zimin, commander of the separate airfield technical support battalion: "Are you sure that you have enough equipment deployed to ensure maintaining the scheduled pace of flight operations as well as flight safety?"

"Yes, I am sure," Vyacheslav Kirillovich firmly replied to the colonel and, to back up his statement, presented well-reasoned arguments and cited convincing calculations.

"Well, time will tell...," the senior check pilot concluded and headed toward the flight line of the military transport regiment's 1st squadron, the aircrews of which would be commencing flight operations as darkness was falling.

The roar of jet engines continued unabated over the base almost all night. And when the last plane landed at first light of day, it was announced that the men had performed all training sorties in excellent fashion and had not violated any flight safety regulations.

Lt Col V. Zimin's men—officers V. Komarovskiy, I. Zelenin, A. Grechishnikov, and other aviation rear services specialists—did everything possible to ensure that the regiment's aircrews accomplished their flight assignments in a high-quality manner.

All airfield technical support battalion personnel received high marks at the post-flight critique and analysis session for ensuring a rapid pace of flight operations and providing prompt and timely aircraft refueling. It was noted that the service vehicle operators directed by young officers R. Pipiya, A. Murygin, and others had done a particularly fine job servicing the aircraft. In short, fueling, replenishing oxygen and compressed air, and engine startup with ground equipment were performed strictly in conformity with established procedures and regulations, without any delays or late departures. And the battalion commander and his deputies deserve a good deal of the credit for this.

Thorough preparation of the runway, taxiways, and all the complex airfield equipment and facilities also was very important in providing high-quality ground support to night operations. This was handled by airfield maintenance company personnel, headed by Capt A. Salozhin. Incidentally, the men of this subunit do not subdivide runway service deterioration into "major" and

"minor," as is sometimes the case. They properly maintain the runway and correct in a prompt and timely manner what at first glance appear to be minor defects: crumbling of concrete and deterioration of joints, and they are aware that a great deal depends on this. Here is a recent example. An inspection revealed that the concrete was damaged at one spot on the runway, and a concrete slab on a taxiway had slumped slightly. This could damage an airplane's landing gear. Company personnel therefore promptly corrected these problems. The necessary materials were hauled to the site in short order on the initiative of officer V. Komarovskiy. Aviation rear services specialist personnel, under the guidance of Captain Salozhin, filled and patched the potholes, leveled the slumping taxiway surface, and readied the field for night operations in a prompt and timely manner.

We should note that the men of this subunit, working under the most difficult conditions, always achieve solid, stable results in their difficult job. The field is ready for operations throughout the year, day and night. The men of the airfield technical support battalion skillfully employ a variety of specialized equipment, which enables them quickly to perform the work required to maintain the runway and other facilities in continuous operational readiness.

POL [Petroleum, Oils, and Lubricants] service personnel, headed by officer A. Grechishnikov, also perform their duties in a conscientious manner. They promptly supply high-grade, unadulterated aviation fuel for aircraft fueling operations. They maintain gas pumps, diesel fuel pumps, and other specialized equipment in good working order.

POL service personnel must be particularly alert during the cold months of the year. The chief of this service and his subordinates keep a close eye on things to make sure that fuel storage tanks and tanker trucks are filled to the top. Otherwise frost can form on the tank walls, which gets into the fuel during pumping operations or when fuel tanker trucks are in motion. This can lead to a serious air mishap.

There is also another important factor. When handling flight operations in cold weather, equipment as a rule operates for short periods of time with frequent stops. This naturally makes it difficult to maintain normal engine operating temperature. Instructive in this regard is the experience of officer Murygin's men. In his platoon they constantly check to make sure that thermostats are operating properly, that fan belt tension is correct, and that cold-weather insulating covers always fit snug to the metal. The drivers warm up their engines thoroughly and constantly monitor the temperature gauge during operation.

As we know, personnel discipline and organization play an important role in exemplary airfield technical support of flight operations. The jobs assigned to all services and subunits are precisely specified on each occasion in the airfield technical support battalion, and the men perform their jobs skillfully and promptly. Adequate time is allocated to readying service vehicles, and aviation rear services personnel are distributed in a differentiated manner among specific work areas. During flight operations their activities are promptly and efficiently coordinated by the airfield technical support duty officer, the competence and intelligent initiative of whom determine in large measure uninterrupted servicing of the regiment during a flight operations shift.

Today almost every man in the airfield technical support battalion is proficiency-rated. Conferences on theory and performance critique and analysis sessions are regularly held with airfield service vehicle drivers, as well as other measures aimed at increasing their specialized knowledge and at acquisition of advanced know-how. Aviation rear services personnel are learning advanced automotive equipment operation and maintenance techniques and are learning to keep automotive equipment in a continuous state of operational readiness.

Successful airfield operations and maintenance consist of many elements, all of which are important. They are discussed in various guideline documents. But there are elements which are particularly typical of the fall-winter operations period.

Aviation rear services personnel keep well in mind the fact that this is a time of sharp, abrupt weather contrasts. It may be sunny in the morning, but by noon there may be rain, fog, or even snow. Unstable weather causes airfield technical support battalion personnel a great deal of problems. The situation with flight operations deteriorates sharply when precipitation is falling as rain, and then the temperature drops below freezing.

With modern equipment and good work organization it is possible to remove ground surface ice, for example, quite rapidly, but it is preferable to take all possible measures to prevent ground surface icing in the first place. Toward this end Lieutenant Colonel Zimin's men have thoroughly studied the weather conditions which occur with this natural phenomenon. And if, for example, a sharp drop in temperature is expected following a thaw, the men do everything possible to ensure that the concrete is dry by this time. A wet runway will be worked over with truck-mounted hot blowers, which is much more economical than removing ice at a later time.

Another characteristic feature of Lieutenant Colonel Zimin's approach is the fact that he constantly maintains a close working relationship with the regimental commander and engineering and technical supervisory personnel. He therefore always keeps current on what is needed to support flight operations. Information about this is immediately reflected in a specially-prepared flowchart, on the basis of which all work is performed by the airfield technical support battalion subunits in strict conformity with the requirements of providing support services initially for the first and later for subsequent departures. Such a chart helps Vyacheslav Kirillovich

refine and detail on a daily basis the distribution of his men and airfield service vehicles in accordance with the flight operations schedule.

Each man knows precisely where he will be working and in what sequence he will be servicing aircraft.

At the same time the OIC of service vehicles maintains constant communication with the air subunit's aviation engineering service supervisor. If the necessity arises, he is able to redistribute service vehicles promptly, in accordance with the aircraft preflighting sequence, flight line positions, and availability of ground power units and fuel trucks.

Close contact between the airfield technical support battalion and the air regiment, and precise planning of aircraft departures and servicing are essential conditions which help officer V. Zimin maintain airfield technical support at a high level, improving unit combat readiness day by day.

Buran Shuttle Pilot Training Described

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[Article, published under the heading "Space Flight Support," by Hero of the Soviet Union Lt Gen Avn S. Mikoyan, Honored Test Pilot USSR: "On Wings From Space"]

[Text] Development of a winged spacecraft capable, following orbital flight, of performing aerodynamic braking in the atmosphere, approaching a destination airfield with the requisite energy reserve and landing "airplane-like" on a runway required enormous exertion of mental, moral, and physical energy on the part of hundreds of workforces. The precision runway landing made by this man-made device signaled the culmination of the entire project.

How were the Buran's handling and flying performance characteristics developed? Returning from orbit, the Buran shuttle was to descend and land without using any engine thrust. The fact is that it has no engines. In aviation such a method was widely used in the past and at one time was even the principal method of landing: airplanes would glide with engines throttled back to idle. Then began the era of jet-propelled aircraft, however, and the landing approach became more complicated. But a power-out landing continues to be prescribed in modern-day aviation in order to complete a flight safely in case of engine failure.

In such instances it is very important correctly to calculate the landing approach. An aircraft in the air possesses certain energy, which is comprised of potential energy (height above the ground) and kinetic energy (airspeed). And this energy must be managed in such a manner as to approach the runway along its centerline extended and a speed close to normal landing approach speed. If the energy is expended prematurely, the aircraft will not reach the runway, and if it is expended too late, the aircraft will overshoot the runway. A go-around is out of the question in such a situation.

A second complexity involved in a power-out landing is the problem of maintaining the proper flight path from the moment the landing approach glide ends to the moment of touchdown. With such an approach an airplane glides at a much steeper angle (15 degrees or more) and at a much greater sink rate (up to 35-40 m/s) than during a normal approach. Upon reaching a certain height, the pilot reduces his angle of glide so as to end up above the approach end of the runway at a height of about 1 meter and in a horizontal attitude.

Usually the "double flare" method is used for this. First the aircraft adjusts into a shallow glide angle, and then flares a second time just prior to touchdown.

The Buran possesses a much poorer lift-to-drag ratio than an airplane and descends with an even steeper flight path—at an angle of about 20 degrees, with a sink rate of 50-60 m/s. For this reason landing is even more complicated, although the Buran does have speedbrakes (deflecting control surfaces), with the aid of which the craft's aerodynamics can be altered within certain limits.

On its first flights the Buran analogue made its landing approach on a shallow glidepath customary for airplanes, using engine thrust. After that they proceeded to power-off landings with a steep approach glide with manual control. This resulted in confirmation of the correctness of the glide path which had been computed and simulated on static test benches. Two runway approaches were made in order to obtain more information during flight. All this was essential in order to proceed with working up the Buran's landing in automatic mode.

The test pilots selected for the training team made hundreds of flights in instrument weather (using data transmitted from the ground) in fighter aircraft, making power-off landings, as well as in flying laboratories (Tu-154), which were aerodynamically similar to the orbiter and had the copilot's position fitted out to simulate the Buran cockpit. It was equipped with a fly-by-wire control system and a computer system. With these aircraft it was possible to check out the mathematics and performance of the ground electronic facilities providing fully-automatic landing approach capability as well as the landing process proper.

But the principal means of developing and confirming the practical possibility of a fully-automatic landing was a Buran analogue fitted with four jet aircraft engines (two with afterburners), a landing gear retraction system (there is only a gear extension system on the Buran), a fuel tank, and ejection seats for the two test pilots. But the main thing is that the analogue craft fully matches the Buran in control system.

Of course they did not right at the outset fly a fully automatic landing on the analogue. Initially they checked out the automatic landing system on a steep-angle approach descent glide, and later right down to completing the landing flare with subsequent manually-controlled touchdown. They made another landing, switching off the automatic landing system immediately after the wheels touched down. Only after this did they make a complete automatic landing to a full stop. There were 16 such flights.

We must mention one more important item. Flight testing was conducted with continuous "accompaniment" by simulation devices and flying laboratories. In the process of this they made partial changes on several occasions in the onboard computer software. With each change the software was "played" initially on testbed equipment, including a full-scale simulator with actual orbiter analogue systems and equipment, after which it would be checked out on a Tu-154 flying laboratory. Only after this would the new software be loaded into the analogue control system.

Pilot training included practice on a dynamic flight simulator, followed by flying the Tu-154 with the same flight profile as on the analogue. All pilots trained on the dynamic flight simulator with abnormal and emergency situations cranked in, and they regularly practiced in order to maintain skills.

During each analogue as well as flying laboratory flight, telemetry obtained from the aircraft would be real-time processed and displayed on the flight experiment control center displays, which enabled the control team to monitor flight path parameters and launch systems operation and, if necessary, to notify and assist the crew.

In conclusion we must stress once again that such a brilliant technical achievement as the flight of the Buran orbiter in automatic mode became possible due to thorough development of all its systems with extensive utilization of mathematical and partial-scale simulation, as well as due to the development of flying laboratories and an orbiter analogue craft.

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